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COMPRENSIVE FRAMEWORK STUDY. CALIFORNIA REGION. MAIN REPORT.(U)
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COMPREHENSIVE FRAMEWORK STUDY

CALIFORNIA REGION

Main Report

OCTOBER 1971

Prepared by:
California Region Framework Study Committee
For Pacific Southwest Inter-Agency Committee
Water Resources Council

The following publications have been prepared under the California Region Comprehensive Framework Study:

Main Report
Appendixes

I	History of Study
II	The Region
III	Legal and Institutional Environments
IV	Economic Base and Projections
V	Water Resources
VI	Land Resources and Use
VII	Mineral Resources
VIII	Watershed Management
IX	Flood Control
X	Irrigation and Drainage
XI	Municipal and Industrial Water
XII	Recreation
XIII	Fish and Wildlife
XIV	Electric Power
XV	Water Quality, Pollution and Health Factors
XVI	Shoreline Protection and Development
XVII	Navigation
XVIII	General Program and Alternatives

(6)

Comprensive Framework Study. CALIFORNIA REGION.

MAIN REPORT.

This report of the California Region Framework Study Committee was prepared at field-level and presents a framework program for the development and management of the water and related land resources of the California Region. This report is subject to review by the interested Federal agencies at the department level, by the Governors of the affected States, and by the Water Resources Council prior to its transmittal to the Congress for its consideration.

(12) 72p.

(11) OCTOBER 1971

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Prepared by the
California Region Framework Study Committee

For the
Pacific Southwest Inter-Agency Committee

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SUMMARY

This study report, prepared by state and federal agencies under the guidance of the United States Water Resources Council, outlines alternative uses of water and related land resources in the California Region between 1965 and 2020. The Region includes all of California and seven percent of Oregon. page 7

In 1965, after more than a century of development, the Region supported 18 million people. Although it still led the United States in agricultural production, it had become increasingly dependent upon manufacturing and the service industry.

By 2020, the population of this Region will be 2½ to 3 times that of 1965; its per capita income, more than four times that of 1965. Such growth will increase the demand upon land and water and will intensify existing environmental problems. The need for food and fiber will have doubled or tripled; and that for recreational opportunities will have tripled. The need for reduction in damage from flood, erosion and wildfire will be three to six times, and that for electric power will be 20 to 25 times, that of 1965. Excluding the need for water to enhance the fishery, to improve water quality, to provide streamside recreation and to modify outflow from the Sacramento-San Joaquin River Delta, the need for water will be 1.3 to 1.5 times that of 1965, assuming that increased crop yields will release from 25 to 30 million acre-feet of water otherwise needed to irrigate crops.

Although the present lag in water quality treatment probably will not be overcome until 2000, the resources of the Region in 2020 can meet most needs of the inhabitants of the Region. Except for conveyance features, existing major water supply works--together with those under construction--generally will satisfy more immediate needs. The Region can reduce flood, fire and erosion damages to a practicable minimum. Some problems of choice will exist among uses and between preservation and development. Lack of suitable land will limit grazing, timber production, waterfowl habitat, and ocean beach recreation. Financial, legal, and physical restrictions will limit recreation development to the point that only about one-third of the recreation needs will be met.

The combined rate of federal and nonfederal investment necessary to meet the need for water-related development would be about the same as at present (1966-1970), although that for federal investment alone would double.

Planning must be sufficiently flexible so as to overcome the difficulties inherent in projecting needs. If growth rates prove less rapid than those projected for this study, the sequence of implementing most proposals will remain as planned even though the date of the implementation is delayed. Planning must provide for acceptable ways to assess the impact of alternative plans upon existing development and upon the environment.

FRAMEWORK STUDY COMMITTEE

The California Region Framework Study Committee directed preparation of the main report and its eighteen appendixes. Representatives of the following agencies comprise this Committee:

CALIFORNIA AGENCIES

HUMAN RELATIONS AGENCY

Public Health, Department of

KLAMATH RIVER COMPACT COMMISSION

RESOURCES AGENCY

Colorado River Board of California
Conservation, Department of
Fish and Game, Department of
Navigation and Ocean Development, Department of
Parks and Recreation, Department of
Reclamation Board*
Water Resources, Department of
Water Resources Control Board

NEVADA AGENCY

COLORADO RIVER COMMISSION OF NEVADA

OREGON AGENCY

STATE WATER RESOURCES BOARD

UNITED STATES AGENCIES

AGRICULTURE, DEPARTMENT OF

Economic Research Service
Forest Service
Rural Electrification Service
Soil Conservation Service

UNITED STATES AGENCIES (Cont'd)

ARMY, DEPARTMENT OF THE

Engineers, Corps of

COMMERCE, DEPARTMENT OF

Business and Defense Services Administration
Environmental Science Services Administration
National Oceanic and Atmospheric Administration

FEDERAL POWER COMMISSION

HEALTH,EDUCATION AND WELFARE,DEPARTMENT OF

Public Health Service

INTERIOR, DEPARTMENT OF THE

Federal Water Quality Administration**
Geological Survey
Indian Affairs, Bureau of
Land Management, Bureau of
Lower Colorado River Land Use Office
Mines, Bureau of
National Park Service
Outdoor Recreation, Bureau of
Reclamation Bureau of
Sport Fisheries and Wildlife, Bureau of

INTERNATIONAL BOUNDARY AND WATER COMMISSION

LABOR, DEPARTMENT OF

SPECIAL TASK FORCE

A task force representing Framework Study Committee agencies wrote the main report:

Agriculture, U. S. Department of . .
Soil Conservation Service . . . . Darwyn Briggs ***

Army, U. S. Department of the
Corps of Engineers . . . . Richard Yamamoto

Interior, U. S. Department of the
Bureau of Reclamation . . . . Ernest Burckhardt

Resources Agency, California
Department of Water Resources . . . . James S. Hanna, Jr.

* Now part of the Department of Water Resources
** Now part of the ENVIRONMENTAL PROTECTION AGENCY
*** Replaced Creighton N. Gilbert

INTRODUCTION

Under the direction of the Water Resources Council and the Pacific Southwest Inter-Agency Committee, the California State-Federal Interagency Group organized the California Region Framework Study Committee (facing page) to study the present and projected future development of water and related land resources in the California Region. The Region is one of twenty-one such regions in the United States. The Water Resources Planning Act of 1965 (Public Law 89-80, 79 Stat. 244) authorized the study.

The Water Resources Council expects its Framework Study to act as a guide to the best use of water and related land resources so as to meet needs between 1965 and 2020.

cont

The studies analyze water and related land resources problems, and appraise the probable nature, extent, and timing of solutions to those problems.

This California Region report considers problems of municipal, industrial, and domestic water supply. It considers problems of irrigation, drainage, electric power, flood control, water quality, navigation, watershed management, fish, wildlife, recreation, minerals, and shoreline. Wherever possible it identifies environmental effects.

The period considered extends from 1965 to 2020. Projections of population, economic development, and costs, etc. are compared with existing conditions in 1965. Thus all evaluations considered water projects operating before or during 1965. Projects placed in operation after 1965 are included as appropriate.

Three rates of population and economic growth have been used to project the needs of 1980, 2000, and 2020 and the effect of these needs upon water and related resources. The lowest rate (Series D-1970) projects a population of 45 million in 2020. The other two rates (Base Plan and OBERS) each project a population of 55 million in 2020, but distribute that population differently between the northern and southern area of the Region. The actual population in 1965 was 18 million.

The needs for water, land, food, and fiber, etc. are compared with the availability of the resources. General data, approximations and experienced judgment supplement detailed information whenever needed to fill in the broad guidelines provided. Approximate costs represent Regional experience and rest upon 1965 prevailing price levels.

The report summarizes the studies reported upon in 18 appendices whose titles appear on the inside of the front cover. Of these, Appendices I and II describe the study itself and the Region studied. Appendix III summarizes and then discusses pertinent treaties, interstate compacts, laws and policies. Appendix IV describes the present economy of the Region and projects future economic growth. Appendices V, VI and VII describe the water, land, and mineral resources available to the Region; and Appendices VIII through XVII, the current status and future needs of specific sorts of development. The final appendix, Appendix XVIII, discusses alternatives for development.

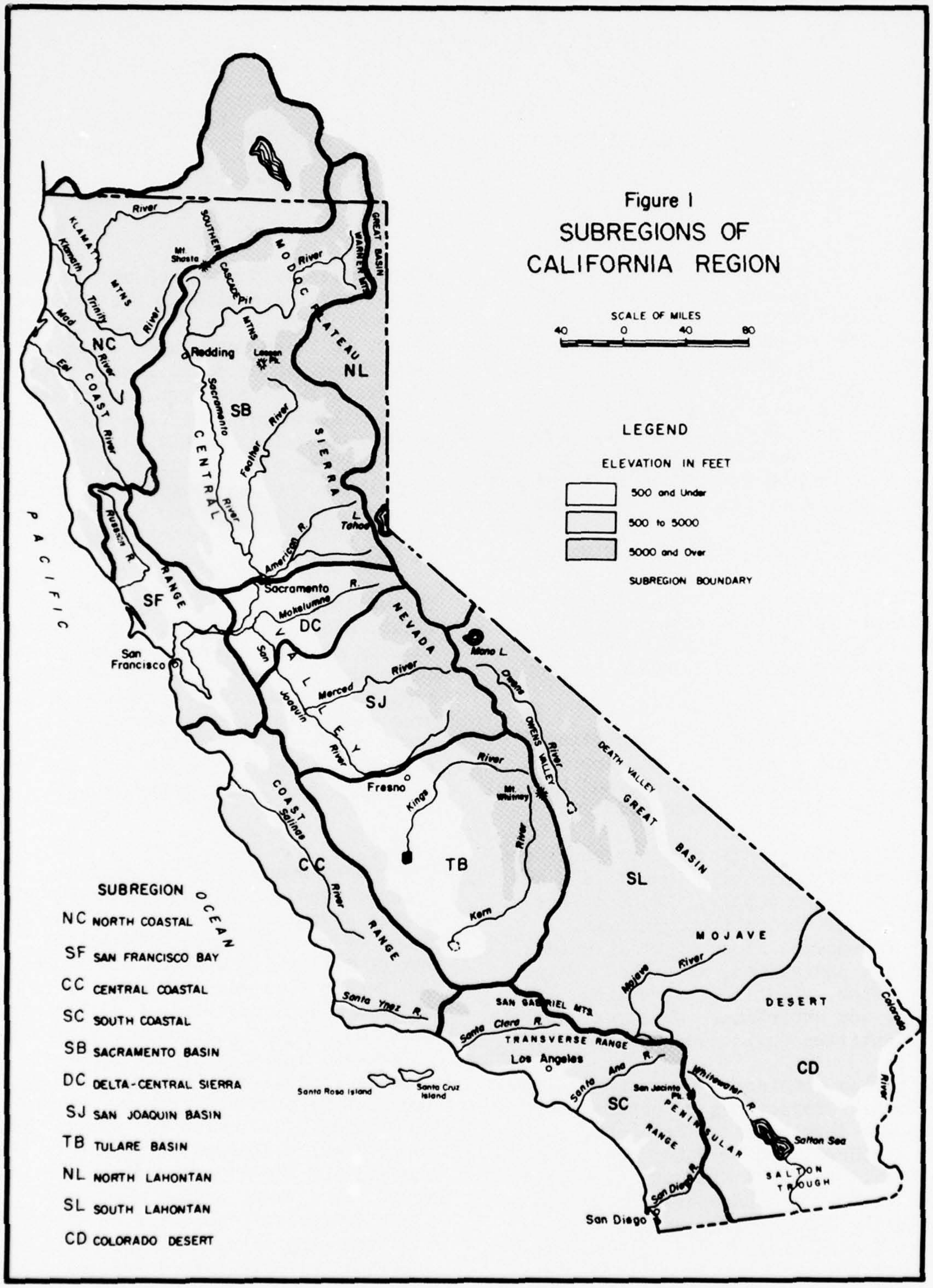


Figure 1
SUBREGIONS OF CALIFORNIA REGION

Part I: REGIONAL CHARACTERISTICS

The California Region includes all of California and seven percent of Oregon. For hydrographic purposes, this study has divided the Region into eleven subregions (Figure 1). The Region extends along the southern two-thirds of western continental United States from north latitude $43\frac{1}{2}°$ to north latitude $32\frac{1}{2}°$. About 900 miles long, it occupies 105,678,000 acres*, or about 165,000 square miles.

Land Forms

Skirting the California coastline from north to south are a series of mountain ranges, the Klamath Mountains, the California Coast Ranges, the Transverse and the Peninsular Ranges. Inland from the Coast Ranges, the Central Valley lies west of the Southern Cascade Range and the Sierra Nevada. Farther inland along the eastern side of the Region lie the Modoc Plateau, the Basin Ranges, the Mojave Desert and the Salton Trough (Figure 1).

The rugged Klamath Mountains ascend to about 9,000 feet. The principal rivers, Klamath and Trinity, have cut deep, twisting gorges through the mountains.

The California Coast Ranges, markedly linear, extend for nearly 600 miles along the coast, southeast from the Klamath Mountains. Their numerous, often-indistinct ridges rise from 2,000 to 7,000 feet and lie separated by the valleys of the Mad, Eel, Russian, and Salinas Rivers, as well as by those of smaller streams.

The Transverse Ranges, of which Santa Rosa and Santa Cruz Islands represent a seaward extension, break the southeastward grain of topography that typifies much of the Region and instead trend eastward as a group of linear ranges. In one of these ranges (the San Gabriel Mountains just north of Los Angeles) peaks reach almost 10,000 feet. Los Angeles itself lies on a broad coastal plain not much above sea level.

The Peninsular Ranges extend southward into Baja California. Although San Jacinto, their highest peak, reaches 10,831 feet, their general altitude is lower than that of the ranges to the north.

The Central Valley dominates the Region inland from the California Coast Ranges. This province is a vast elliptical plain 400 miles long and 50 miles wide. Its floor varies from a few tens to a few hundreds of feet above sea level. The southward-flowing Sacramento River system drains the northern half of this valley; the northward-flowing San Joaquin River system drains the southern half. The two rivers converge in the Sacramento-San Joaquin Delta. From here, the water flows, via San Francisco Bay, through the only exit from the mountain-rimmed valley, the Golden Gate.

The Southern Cascade Range contains two prominent volcanic mountains: Lassen Peak (10,457 feet) and towering Mount Shasta (14,162 feet). The width of the range, throughout most of its north-south length, is less than 25 miles.

In the Sierra Nevada, a great westward-dipping fault block 385 miles long and 85 miles wide, lofty mountain peaks tower above precipitous gorges and canyons. About a dozen major streams traverse the gentle western slope of the range and flow into the Sacramento and San Joaquin Rivers. Many of these streams

* 104,182,000 acres of land; 1,496,000 acres of water.
101,564,000 acres in California; 4,114,000 acres in Oregon

occupy deep valleys--some a half-mile deep. To the north, the crest elevation of the highest Sierra Nevada peak is less than 8,500 feet. Thereafter, crest elevations increase toward the south, culminating in Mount Whitney, 14,495 feet high--highest mountain in the coterminous United States. The east side of the Sierra Nevada, throughout much of its length, drops precipitously into Owens Valley. Near Mount Whitney, this drop is almost two miles in a horizontal distance of six.

The Modoc Plateau is a plateau of volcanic rock whose average altitude is 5,000 feet above sea level. Above the plateau, numerous volcanic cones rise an additional 2,000 feet. In its extreme northeast corner, the rugged Warner Mountains tower almost a mile. They culminate in Eagle Peak, 9,883 feet above sea level.

The Basin Ranges occupy desert. Extremely rugged, linear ranges, they attain altitudes exceeding 14,000 feet. The highest (White Mountain Peak near the Nevada border) rises to 14,242 feet.

The Basin Ranges include Owens Valley and Death Valley. The latter contains the lowest point on the North American Continent. It lies only 80 miles from Mount Whitney, but is 282 feet below sea level.

The Mojave Desert, a great expanse of immense, sandy valleys, dry lake bottoms, and short, rugged mountain ranges, extends southward to the California border at the Colorado River.

The Salton Trough, an alluvium-filled basin, lies just north of the Mexican border. A feature peculiar to this desert is that evaporation and seepage dry up most of the rivers in their valleys. The Salton Trough contains the Salton Sea, the largest lake in Southern California. The Salton Sea lies 235 feet below sea level. The highest peaks of the Salton Trough rise almost to 7,500 feet.

Geology

The geologic history of existing land forms is complex.

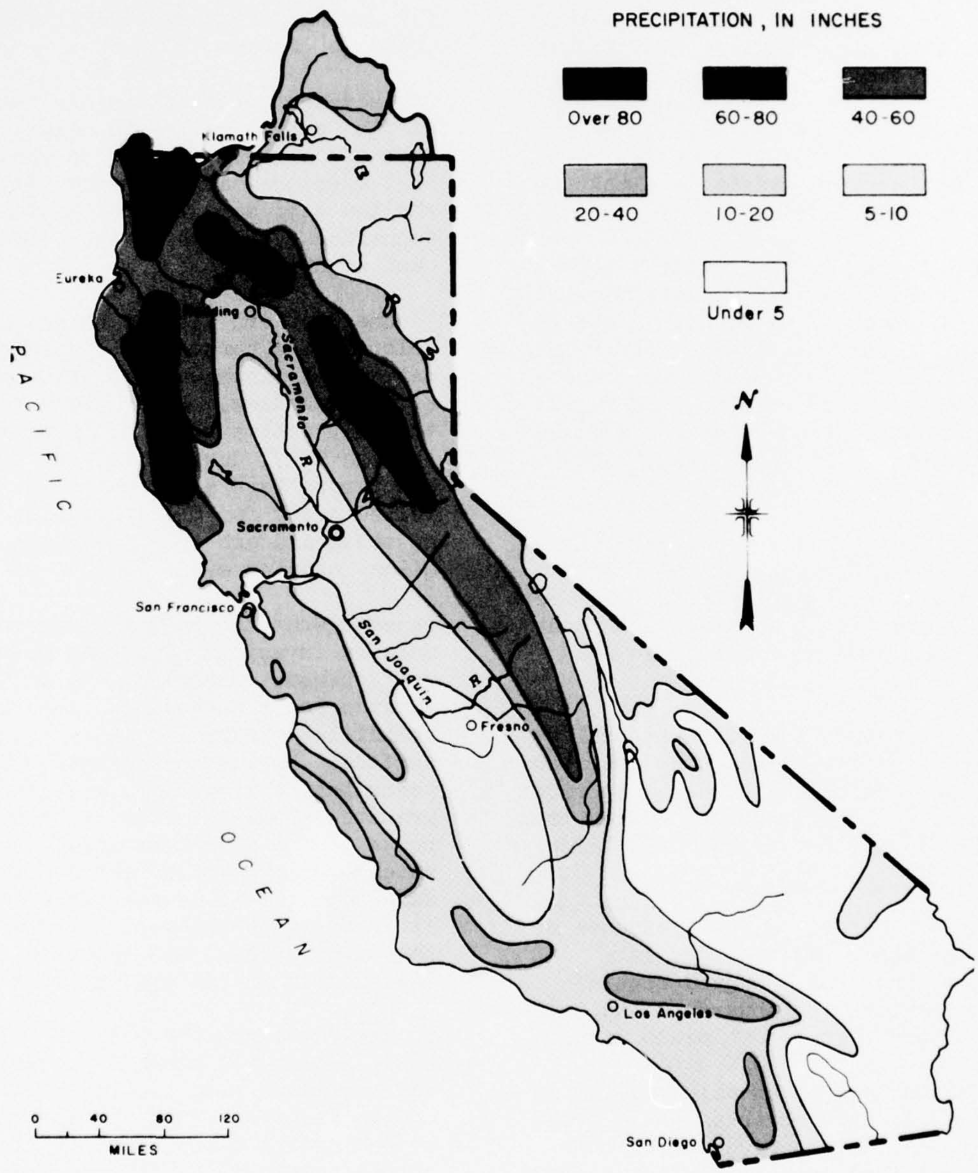
The sediment which fills the huge trough of the Central Valley is miles deep. Some of this sediment is marine, deposited when the valley formed part of a shallow sea; some is continental, deposited by rivers as they eroded adjacent mountains.

In the Southern Cascade Range, dark-colored lava burst forth, forming volcanoes and flows which covered hundreds of square miles. Lassen Peak remains the only active volcano. From 1914 through 1917, during its most recent eruptions, lava and great blasts of gas felled trees for miles around; clouds of steam and ash rose more than five miles into the air.

Beneath what today is the Sierra Nevada, massive invasions of molten granite rock pushed, contorted, and melted the layered rocks above them, then cooled and solidified many miles beneath the earth's surface. During the hundred million years that followed, rivers exhumed this granite. Today it lies exposed as the peaks of the Sierra Nevada. The rivers which exhumed granite carried the mud, sand, and gravel downstream and deposited it in a sea to the west. The sediments have since folded and uplifted, and now lie exposed in the present Coastal Ranges.

In ancient times, the Gulf of California extended northward through the Salton Trough and inundated both the Imperial and Coachella Valleys. Then the Colorado River, extending its delta, built a land bridge across the Gulf. After the land bridge was formed, and the river was again flowing southward to the Gulf, the inland body of water evaporated, exposing the Salton Trough. The land bridge remains as the southern part of the Imperial

Figure 2: MEAN ANNUAL PRECIPITATION



Valley and the adjoining Mexicali Valley in Mexico.

Climate

Instead of the usual four seasons, most of the Region has two--a dry, warm summer season, and a wet winter season. The latter lasts November through March in the southern part of the Region; it lasts October through April in the northern part.

Although the range in latitude is great, latitude does not influence climate here as strongly as it does elsewhere. Instead, topography causes isotherms to follow topographic contours and move from north to south rather than from east to west. Because of abrupt changes in topography, the range of temperature, the velocity of wind, and the amount of precipitation often vary greatly within a few miles. The Sierra Nevada and Cascade Ranges effectively block the movement of air masses from the east. In addition to topography, the Pacific Ocean and the movement of the offshore Pacific high pressure areas also influence the climate. The ocean tends to equalize summer and winter temperatures along the coast and its inland-leading valleys. The offshore Pacific high pressure area moves southward in the winter, permitting cold Canadian air and winter storms entry into the northern part of the Region. Contrariwise, the high moves northward in the summer, thus deflecting the cool air masses back toward Canada.

Winter storms from the west bring precipitation which falls as rain in the valleys and foothills and as snow in the mountains. Figure 2 shows the mean annual precipitation. Precipitation increases from south to north and falls heaviest on the west side of the mountains below 6,000 feet. When the snowpack melts in the spring, the heaviest runoff descends the west side of the mountains. To the south, heavy rains in early fall result from cyclonic storms occurring to the southeast.

The marine climate of the coast is characterized by warm winters, cool summers, high relative humidity, and little daily or seasonal range in temperature. Inland, the more-continental climate is characterized by warmer summers, colder winters, lower relative humidity, and greater range in temperatures.

Topography determines the change from marine to continental climates.

Topography also controls the amount and the distribution of the winter precipitation. Although snow does fall in the Sierra Nevada at elevations as low as 2,000 feet, it does not remain long below elevation 4,000 feet. In the middle Sierra, snow falls most heavily between 7,000 and 8,000 feet. At Tamarack, in Alpine County, the annual depth averages 450 inches.

Regional temperatures have varied from 134° to -45°. Based on long continued periods of heat, Death Valley is the hottest place in the world.

The frost-free period ranges from 365 days along the extreme south coast to about 260 days along the north coast and in the Central Valley. It averages 100 to 120 days in the northeastern interior valleys, and 282 to 322 days in the Imperial Valley.

As a result of the Pacific high pressure area, winds along the coast prevail from the northwest. Elsewhere, local topography, atmosphere pressure gradients, and proximity to the ocean and mountains influence winds.

Relative humidities, comparatively high along the coast, generally increase from south to north, and from winter to summer. Along the north coast, they are high throughout the year. Within the interior lowland areas west of the Southern Cascade Mountains and the Sierra Nevada they are low in summer and high in winter. East of these ranges, humidities are low in summer.

Summer thunderstorms strike the interior in the higher mountains and desert areas. When precipitation is low, lightning causes destructive forest fires . Coastal thunderstorms, weak and infrequent, can occur in any month. Tornadoes strike somewhere about once a year. Flooding which can occur at any time is worse in winter when prolonged storms accompanied by high temperatures can melt the snowpack. Localized, short-duration convective-type storms sometimes flood small drainages. Dry weather and drought, sometimes persistent, on occasion occur during the winter.

The climate favors the growth not only of most crops grown commercially elsewhere in the United States, but also of certain crops not grown commercially elsewhere in the United States. Because rainfall distribution generally does not favor dryland crop production, farmers must irrigate.

Two characteristics of climate markedly affect planning in the Region: 1) precipitation, and thus streamflow, differs so widely between summer and winter that farmers in most areas have had to irrigate even their pasturelands, and major cities have had to build reservoirs and aqueducts to insure year round water; and 2) the prevalence of both flood and drought years requires that planners design water systems concordant with both.

History

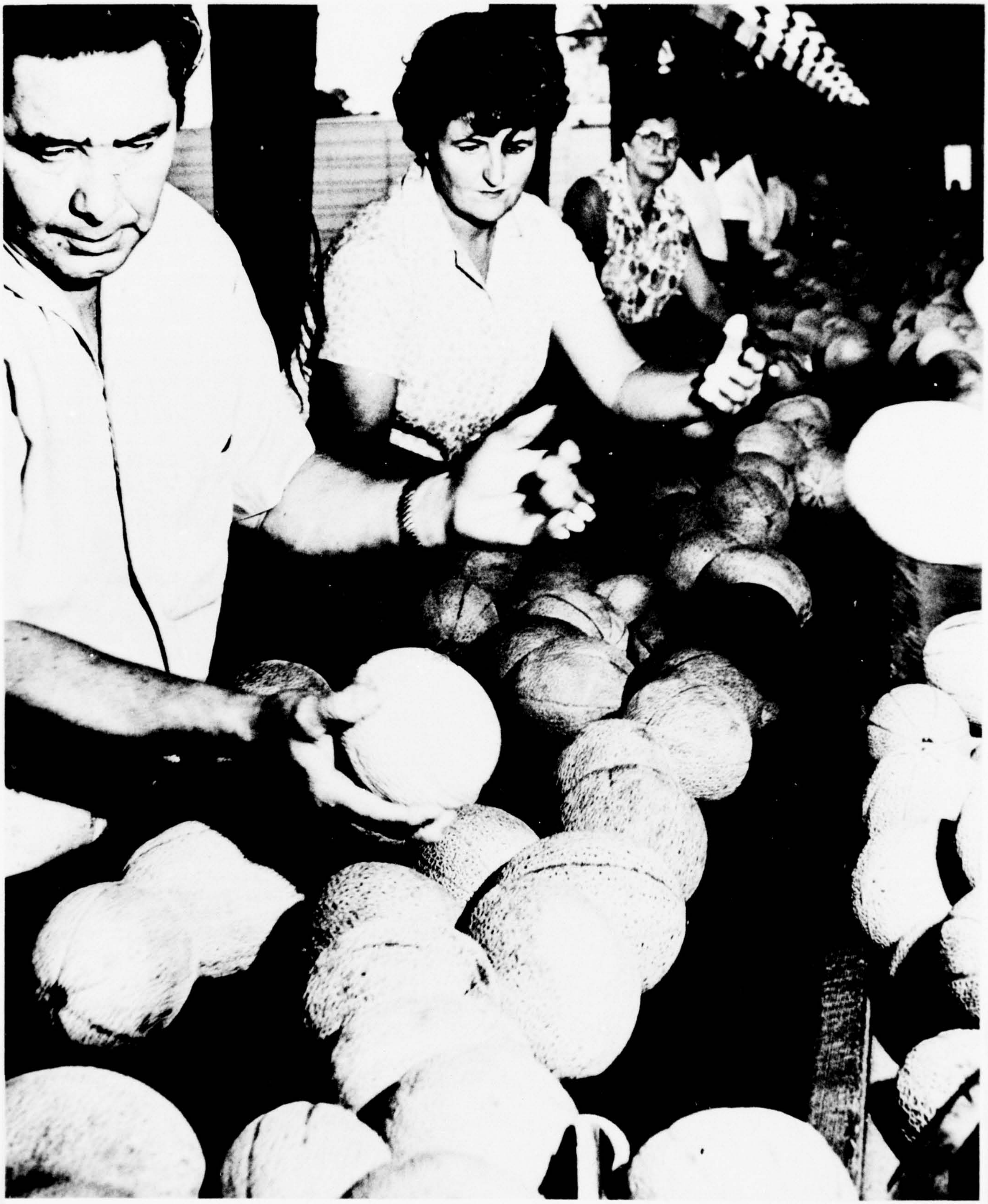
Navigators in the service of Spain first approached the California coast in 1542, 50 years after Columbus discovered America. They found a tribally-organized, stone-age civilization. Although primarily hunters and gatherers, the Indians practiced some agriculture along the Colorado River. European settlement began in 1769, when the Spanish colonized California.

In 1819, Spain conveyed the Oregon area to the United States; in 1848, Mexico transferred California to the United States. Of some 200,000 people in California at that time, only about 15,000 were of European descent. The Spanish and Mexican periods introduced a pastoral society which raised cattle on extensive land grants. But the discovery of gold in 1848 drew settlers from all parts of the world.

California became a state in 1850; Oregon in 1859.

As the more accessible gold deposits were exhausted, agriculture resumed its dominant position as a means of livelihood. By the 1870s ships and transcontinental railroads delivered wheat and timber, and later oranges and other fruits and vegetables, to world markets.

Mining had initiated large scale water development. By the late 1800s and early 1900s the experience and capital accumulated at that time moved into irrigation, city water supply, and hydroelectric power development. World War I spurred industrialization and introduced the age of the automobile. Industrialization continued at an accelerating rate through World War II to the present. By 1965, the population slightly exceeded 18 million.



Part II: REGIONAL ECONOMY

Although by 1965 the Region had become heavily dependent upon manufacturing and service industries, California itself led every other state in the value of farm produce. Indeed, as measured in terms of value added within the Region, processing of food and kindred products formed the largest sector of the manufacturing industry. In another area, the aerospace and defense industries led trends toward the production of electronic instruments. In terms of gross regional product alone, the Region ranked high among all the nations of the World.

People

More than 18 million people lived within the Region in 1965, more than 90 percent of them in cities. Urban populations concentrated in Southern California, around San Francisco Bay and, less densely, in the Central Valley. About 38 percent of the people were employed. Census data for 1960 indicates that 40 percent of the people were under 14 or over 65 and thus made up only a minor part of the labor force.

Forest Products

The Region differs from others in the west in that it possesses both the supply and a large demand for lumber and wood products.

Mill operators now process 27 different species of wood. Los Angeles County, within the South Coastal Subregion, is one of the major secondary wood processing areas of the country.

In the United States, only Oregon and Washington--the latter very recently--surpass California in annual harvesting of timber. California supplies one-seventh of the nation's lumber, most of its commercial redwood, and four-fifths of its sugar pine. Oregon's Klamath Basin supplies pine and fir products and supports the largest lodgepole pine operation in the West. In 1965, the California Region produced one million Christmas trees and 5.7 billion board feet of lumber--enough to build 570,000 homes. A growing plywood industry is producing one-tenth of the nation's softwood plywood. Wood pulp and particle-board industries, postwar developments, use previously unused mill residues almost exclusively as raw material.

Agriculture

In 1965, the Region's farms produced crops worth about $2.5 billion.

Almost 7,000,000 acres of its cultivated lands lie in the Central Valley within the Sacramento Basin, San Joaquin Basin, Delta-Central Sierra, and Tulare Basin Subregions. This valley produces rice, cotton, sugar beets, tomatoes, and other crops.

More than 1,600,000 acres of cultivated lands lie in coastal valleys, mostly in the San Francisco Bay, Central Coastal, and South Coastal Subregions. Conditions here favor the growth of a wide variety of climatically restricted crops. Artichokes, brussels sprouts, avocados, spinach, flower seeds, and citrus grow here on about one million acres. Such specialty crops account for nearly a half billion dollars annually.

More than 600,000 acres of cultivated lands lie in the interior desert valleys of Imperial, Coachella, and Antelope, in the Colorado Desert and South Lahontan Subregions. The Region harvests about 15 percent of its alfalfa on more than 200,000 acres in these valleys. It produces nearly $9 million worth of grapefruit and dates on just 12,000 acres in the Imperial and Coachella Valleys. It produces much of its supply of winter truck crops in these valleys.

The Klamath Basin in the North Coastal Subregion grew farm crops valued at more than $27 million in 1965. The most important of these were potatoes and malting barley.

Other cultivated lands lie scattered among mountain plateaus and valleys. Although their total acreage is small, they produce forage and hay crops important to local livestock industries.

Minerals

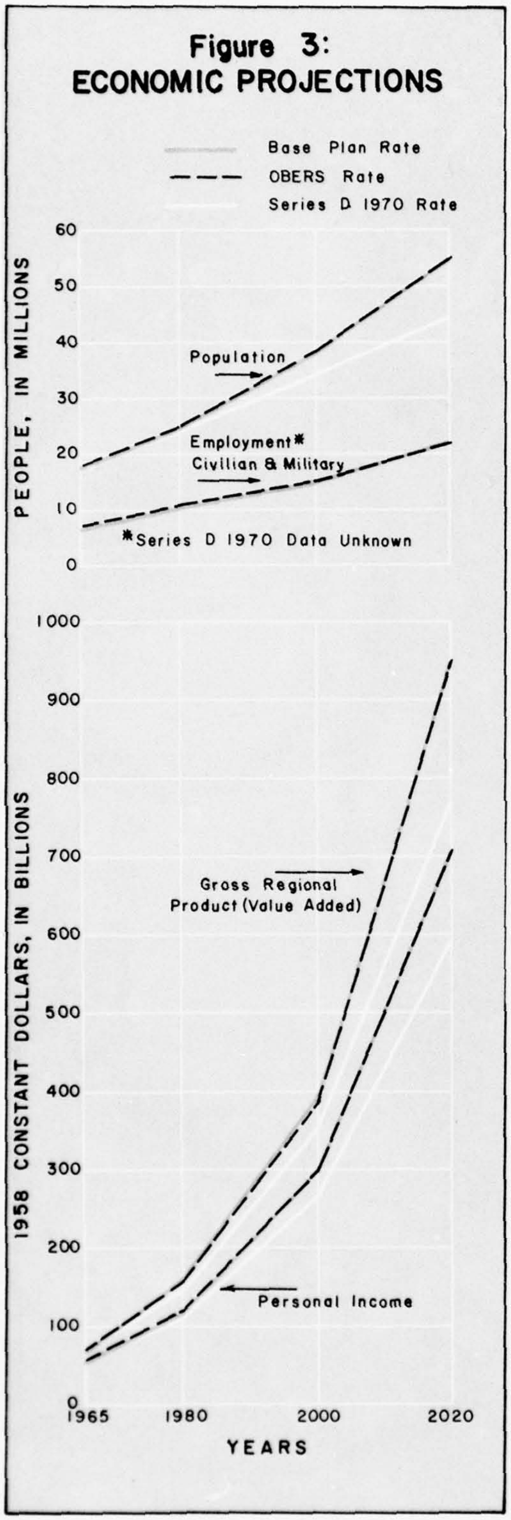
Minerals other than gold have proved more lasting than gold in importance to the Region. In 1965, the Region produced 48 mineral commodities valued at $1.6 billion. Petroleum and natural gas provided about two-thirds of this amount; nonmetals, principally cement, sand, and gravel, provided about one-third. The Region produces major amounts of asbestos, boron minerals, sodium sulfate, diatomite, mercury, rare earth metals and tungsten.

Service, Trade, and Transportation

Whether measured by the number of people they employ, or by their contribution to the gross regional product, services rank ahead of manufacturing and of trade and transportation.

In addition to personal, professional, vocational, and social services, such services include those of government agencies, insurance companies, real estate brokers, banking houses, and wholesale and retail distributors, all linked by the communications and utility industries.

International trade exemplifies the economic growth of the Region. California's exports almost doubled between 1962 and 1967; its imports increased more than 60 percent. In dollars, the San Francisco Bay area led in exports. Of 41 customs districts, those of Los Angeles and San Francisco ranked fifth and sixth nationally in value of total trade in 1967.



Economic and Population Projections

Projections to 2020 assumed three rates of economic growth; the OBERS, Base Plan, and Series D-1970 rates (Figure 3).

The first two rates, OBERS and Base Plan, each assume that the population of the Region in 2020 will approach 55 million. Each, however, distributes this population differently within the Region: the OBERS rate projects about eight million more people in Southern California than does the Base Plan rate. The Series D-1970 rate assumes that the population in 2020 will approach only 45 million.

OBERS Projections. At the request of the Water Resources Council, the Office of Business Economics (OBE) of the United States Department of Commerce and the Economic Research Service (ERS) of the United States Department of Agriculture developed OBERS population projections and estimated needs for food and fiber production for the entire United States.

To do so, they combined projections of gross national product, population, labor force, employment, hours worked and product per man-hour. They considered high, medium, and low projections and judged the mid-level value to be the most probable. This mid-level value, the Series C birthrate, uses a 1.3 percent annual growth rate. The OBERS rate of economic growth for the Region was derived from consideration of historical relationships between regional and corresponding national figures.

Base Plan Projections. Base Plan projections are a regional modification of OBERS projections. They use the same regional population as OBERS projections but distribute that population differently within the Region. They apply the differentials in rates of natural increase between the Region and the United States to recent projections of national rates of natural increase. They assume that in Southern California natural increase will provide

the labor demands of a growing economy and that migration into the area will decline. They establish Southern California labor demands on the basis of specific estimates of economic activity in 1970 and 1980.

Elsewhere, they assign appropriate proportions to the total Regional population for 2020 under high, medium, and low assumptions.

Series D-1970 Projections. In January 1970, the California State Department of Finance, basing its data on more recent survey information, released provisional population projections to 2000 for California. The Department of Finance used Series D birth projections of the 1960 Census. Series D of the 1960 Census suggests an annual national birthrate of about 1 percent, as opposed to the 1.3 percent rate of Series C, 1960 Census. Migration into California was assumed to remain at 200,000 annually from 1974 to 2000.

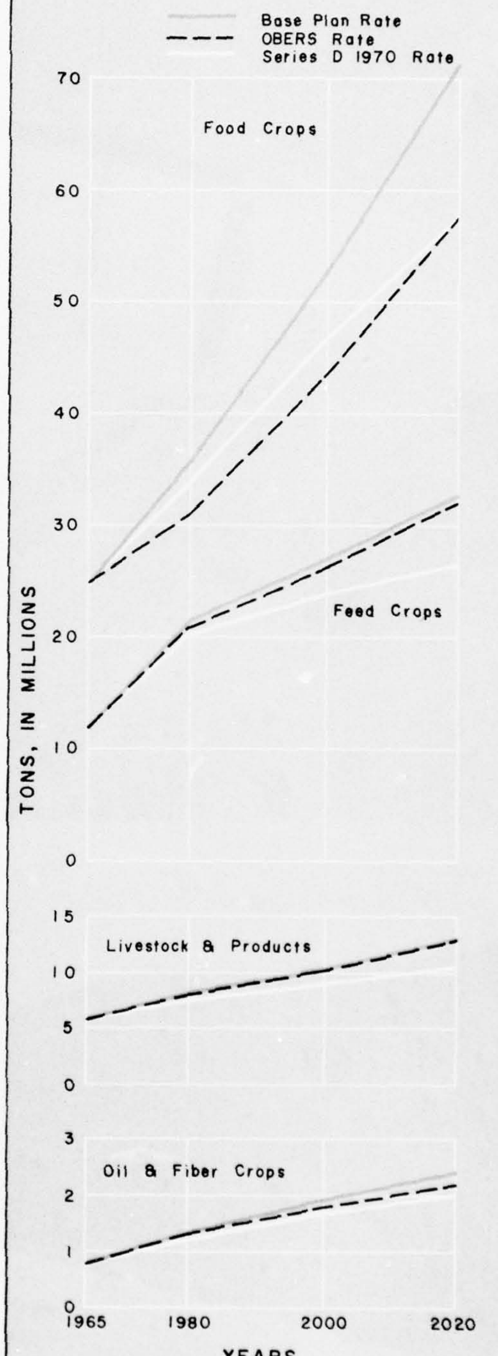
The California Department of Water Resources used Series D-1970 projections in its Bulletin No. 160-70,"Water for California--Outlook in 1970."

For these framework studies, the basic Department of Finance projections for California were extrapolated to year 2020. Base Plan population projections for Oregon were then added to the Series-D 1970 projections. Employment projections for Series D-1970 were not derived.

Food and Fiber Needs

From the economic projections were estimated future food and fiber needs to accompany the three levels of economic activity (Figure 4). Food crop production needs under OBERS projections are considerably lower than those under Base Plan projections because OBERS projections assumed a lower percentage of national food crop production in the Region.

Figure 4:
FOOD AND FIBER NEEDS



Part III:

WATER AND RELATED LAND RESOURCES DEVELOPMENT

In this Region of rainless summers and often remote water sources, the development of land often has depended upon the concomitant development of water.

Water Development

Water development has been progressing through three stages: (1) local diversions from a river, (2) storage of water from a river for use within the river basin, and (3) storage and transport of water from river basins abundant in water to those deficient in water. In areas such as the San Joaquin Valley, the development of electrically powered pumps made possible the exploitation of ground water as early as 1900, and postponed for many years the need to store or import surface water. Water development in the Region has not proceeded uniformly. Simple single-purpose works exist beside complex multiple-purpose works, each governed by laws and managed by agencies that have likewise evolved unevenly. Such agencies include the State and Federal Governments, water and irrigation districts, municipal water works, mutual water groups and commercial companies.

By 1965, the metropolitan areas of Southern California and the San Francisco Bay, having developed their nearby water, had tapped more distant waters. Los Angeles had built the Owens Valley Aqueduct, now 300 miles long. The Metropolitan Water District of Southern California had built the Colorado River Aqueduct. Southern Californians supplement such far flung surface works with facilities to replenish ground water. To the north, San Francisco had brought water from Hetch-Hetchy Valley; San Francisco Bay cities to the east had brought water from the Mokelumne River. In the Central Valley, storage in mountain reservoirs now supplements irrigation systems which began as local valley canals. Often this storage not only conserves water, but controls floods, and generates energy. Such multiple-purpose storage exists behind Shasta Dam on the Sacramento River, Folsom Dam on the American River, and Pine Flat Dam on the Kings River.

The Federal Central Valley Project and the California State Water Project move water hundreds of miles. By 1965, the federal project, built to serve the Central Valley, was operating; and the state project, built to serve the Central Valley, the San Francisco Bay area, and Southern California, was being constructed.

Public utility systems have developed extensive hydroelectric power on mountain streams such as the Pit, San Joaquin, Feather, Kings and Kern Rivers.

About 86 percent of the water diverted from streams and pumped from the ground serves to irrigate farmland; about 12 percent, to satisfy municipal and industrial needs; and about two percent, to satisfy other needs.

Surface Water. The river systems provide spawning habitat for salmon and other anadromous fish, which return from the ocean to ascend their native streams at spawning time. Cold and warm water streams and reservoirs, canals, tidal channels, lakes and ponds provide spawning habitat for inland fish. This habitat includes more than 29,000 miles of streams, about 8,000 miles of canals, and more than 500,000 acres of lakes, ponds, and reservoirs.

Both single and multiple-purpose works regulate streamflows. Hundreds of miles of artificial channels, canals, and pipelines convey water from surface streams. Levees and reservoirs provide flood control both singly and in con-

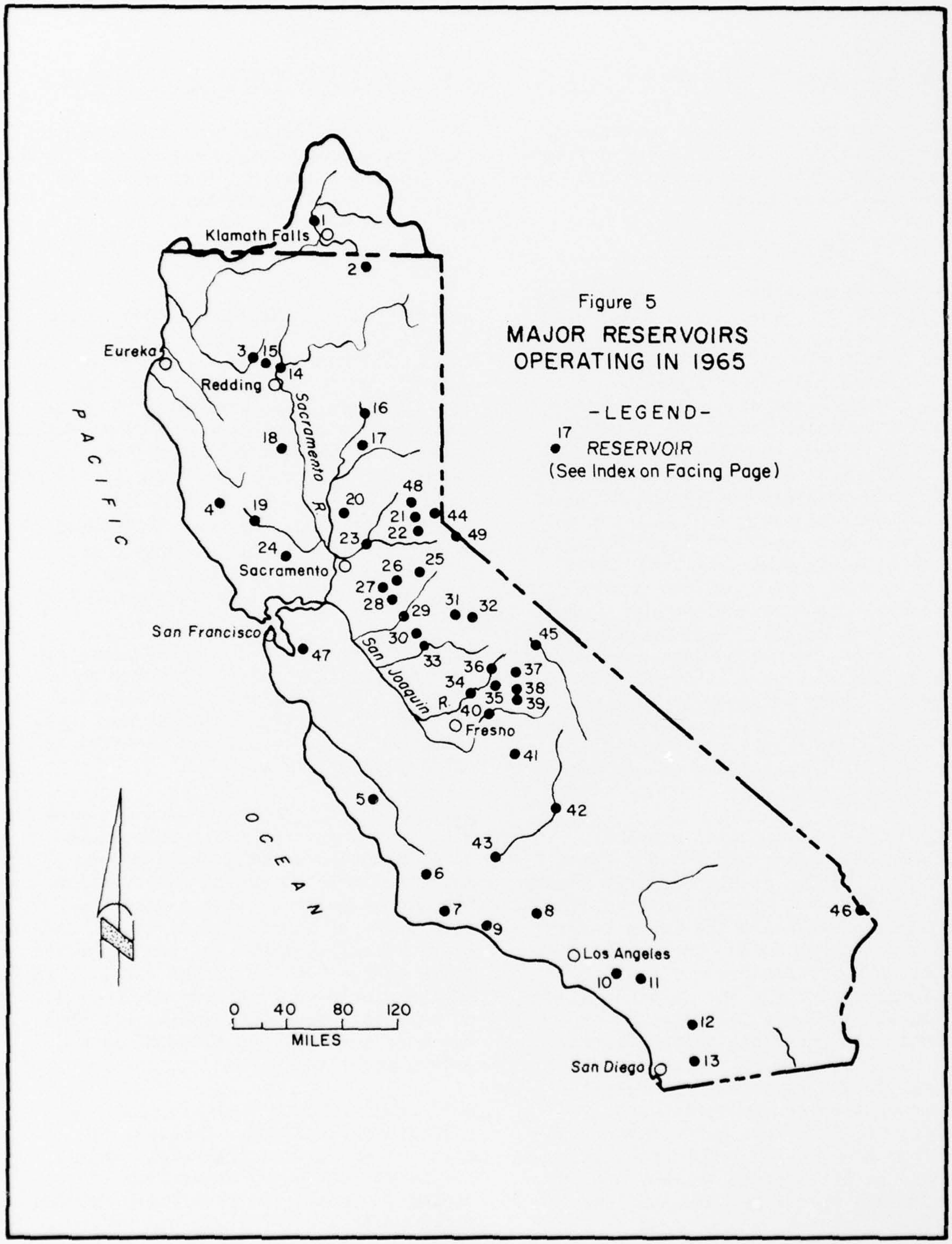


Figure 5
MAJOR RESERVOIRS
OPERATING IN 1965
-LEGEND-
17
RESERVOIR
(See Index on Facing Page)
Klamath Falls
Eureka
Redding
Sacramento R.
Sacramento
San Francisco
San Joaquin R.
Fresno
Los Angeles
San Diego
PACIFIC
OCEAN
0 40 80 120
MILES
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junction with other works. In 1965, hydroelectric powerplants generated about 30 percent of the electrical energy consumed in the Region. Usable surface reservoir capacity approximates 27 million acre-feet. It is distributed among several hundred reservoirs, 49 of which each can store more than 100,000 acre-feet of water (Figure 5). Reservoirs can store about 6.0 million acre-feet of water specifically for flood protection during the flood season.

Ground Water. Water pumped from the ground has greatly assisted economic growth in the Region. Much of such water irrigates farmland. It also provides almost half the supply for cities, industries, homes, and livestock. Overdrafts in many areas have resulted in water deficiency, water quality deterioration, and land subsidence.

In many areas, Californians deliberately use surface water to recharge the ground water basin. They do so by means of modified streambeds, or by flooding recharge basins, pits, ditches and furrows, or by injection wells. The latter method has been used along the coast of southern California to create a hydraulic barrier to prevent intrusion of sea water into overdrawn ground water basins.

INDEX TO Figure 5: Major Reservoirs* Operating in 1965

Map Reference Number	Dam	Purpose**							Maximum Reservoir				Recreation Land (acres)	Total Flood Control Storage (1,000 acre-feet)	Project	
		C	F	I	M	N	P	R	Storage (1,000 acre-feet)	Elevation (feet)	Shoreline (miles)	Area (acres)			Federal	Other
1	Upper Klamath Lake	-	-	I	-	-	-	-	873	4,143		90,100			X	-
2	Clear Lake	-	F	I	-	-	-	-	527	4,480	65	24,800	7,679	302	X	-
3	Trinity	-	-	I	-	-	P	-	2,448	2,370	145	16,400	25,625	292	X	-
4	Coyote	C	F	-	-	-	-	R	122	765	17	1,956	1,500	48	X	-
5	Nacimiento	C	F	I	M	-	-	R	350	800		5,370		150	-	X
6	Twitchell	-	F	I	-	-	-	-	240	652		3,700		89	X	-
7	Cachuma	-	-	I	M	-	-	-	205	750	42	3,100	300	32	X	-
8	Santa Felicia	C	-	I	M	-	-	-	100	1,055		1,240			-	X
9	Casitas	-	-	I	M	-	-	R	252	567	31	2,700	1,800		X	-
10	Prado	-	F	-	-	-	-	-	217	543		8,850	5,387	217	X	-
11	Lake Mathews	-	-	I	M	-	-	-	182	1,390		2,750			-	X
12	Henshaw	C	-	I	-	-	-	-	204	2,727		6,020			-	X
13	El Capitan	C	-	I	M	-	-	-	116	750		1,580			-	X
14	Shasta	-	F	I	-	N	P	-	4,552	1,065	365	29,500	2,875	1,359	X	-
15	Whiskeytown	-	-	I	-	-	P	R	241	1,210	36	3,200	15,721	35	X	-
16	Lake Almanor	-	-	-	-	-	P	-	1,308	4,500		28,257			-	X
17	Bucks Lake	-	-	I	-	-	P	-	103	5,155		1,827			-	X
18	Black Butte	-	F	I	-	-	-	-	160	473	40	4,600	3,050	232	X	-
19	Clear Lake	C	-	I	-	-	-	-	1,100	1,326		43,800			-	X
20	Camp Far West	C	-	I	-	-	-	R	103	300		2,680			-	X
21	L. L. Anderson	C	-	I	M	-	P	-	134	5,245		1,418		7	-	X
22	Union Valley	C	-	I	M	-	P	-	271	4,870		2,860			-	X
23	Folsom	-	F	I	-	-	P	-	1,010	466	75	11,500	4,875	510	X	-
24	Monticello	-	F	I	M	-	-	R	1,602	440	165	20,700	1,705	300	X	-
25	Salt Springs	-	-	-	-	-	P	-	139	3,958		925			-	X
26	Pardee	-	F	-	M	-	P	-	210	568		2,134		} 200	-	X
27	Camanche	-	F	-	M	-	-	-	432	235		7,700			-	X
28	New Hogan	C	F	I	-	-	-	R	325	713	50	4,400	1,300	196	X	-
29	Melones	C	-	I	-	-	P	-	112	718		1,843			-	X
30	Don Pedro	C	F	I	-	-	P	-	289	605		3,100		213	-	X
31	Cherry Valley	C	F	-	M	-	P	-	268	4,700		1,765		102	-	X
32	O'Shaughnessy	C	F	-	M	-	P	-	360	3,806		1,960		182	-	X
33	Exchequer	-	-	I	-	-	P	R	289	707		2,720			-	X
34	Friant	-	F	I	-	-	-	-	521	578	43	4,900	1,950	390	X	-
35	Shaver Lake	-	-	-	-	-	P	-	135	5,370		2,177			-	X
36	Mammoth Pool	-	-	-	-	-	P	-	123	3,330		1,100			-	X
37	Vermilion Valley	-	-	-	-	-	P	-	125	7,642		1,890			-	X
38	Courtright	-	-	-	-	-	P	-	123	8,180		1,621			-	X
39	Wishon	-	-	-	-	-	P	-	128	6,539		1,000			-	X
40	Pine Flat	C	F	I	-	-	-	-	1,000	952	67	5,970	6,800	1,113	X	-
41	Terminus	-	F	I	-	-	-	R	150	694	22	1,945	450	258	X	-
42	Isabella	C	F	I	-	-	-	-	570	2,606	38	11,400	2,600	842	X	-
43	Buena Vista	-	-	I	-	-	-	-	205	296		24,000			-	X
44	Lake Tahoe	-	-	I	-	-	P	-	732	6,229		120,000			X	-
45	Long Valley	-	-	-	M	-	P	-	183	6,782		5,280			-	X
46	Parker	-	F	-	M	-	P	-	648	450	200	20,400	1,000	180	X	-
47	Calaveras	C	-	-	M	-	-	-	100	753		1,450			-	X
48	Lower Hell Hole	C	-	I	-	-	P	R	208	4,630		1,250		17	-	X
49	Topaz Lake	C	-	-	-	-	-	-	125	5,006		2,300			-	X

* Reservoirs whose maximum capacity equaled or exceeded 100,000 acre-feet

** C = Conservation N = Navigation
F = Flood Control R = Recreation
I = Irrigation P = Power
M = Municipal & Industrial

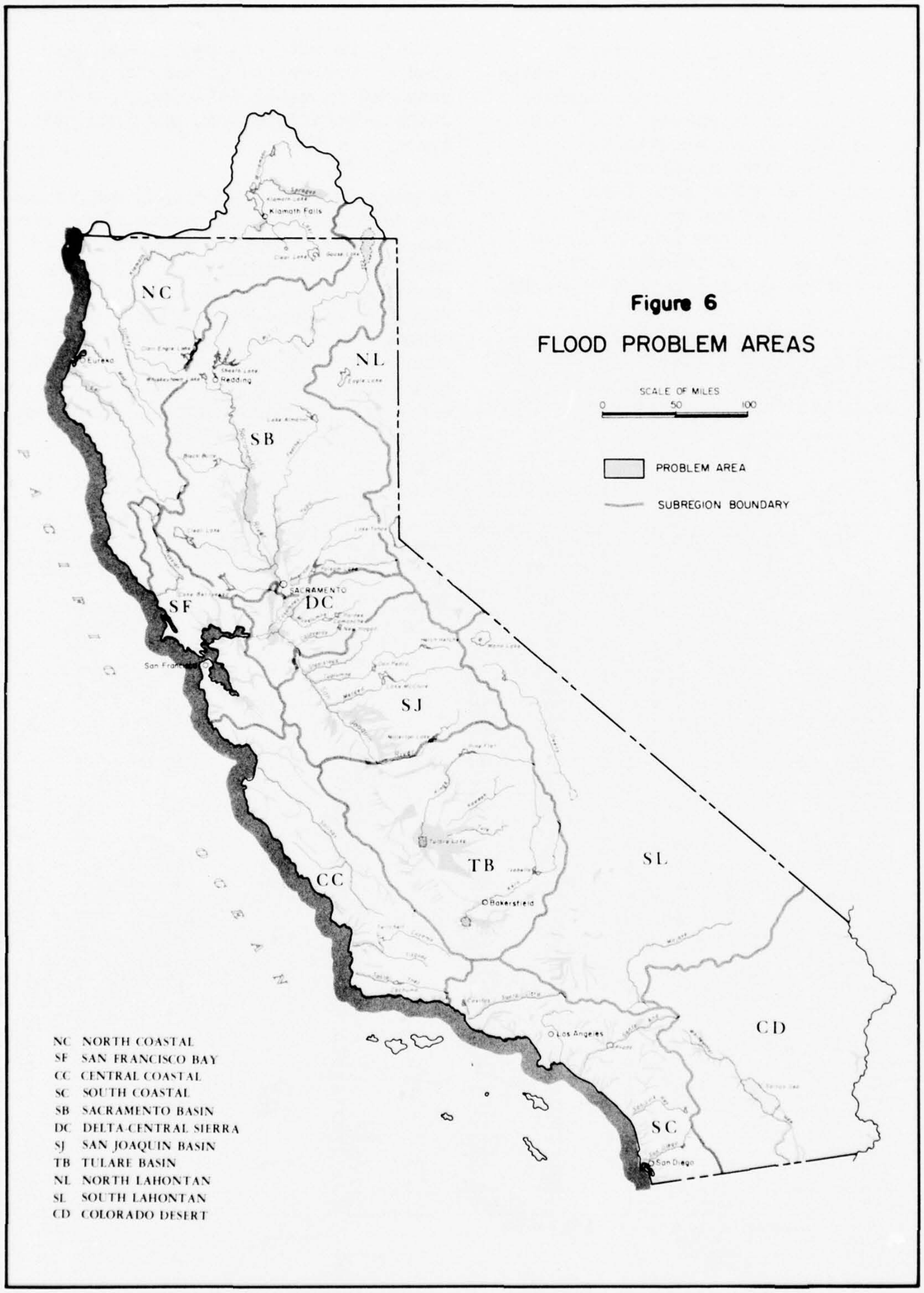


Figure 6
FLOOD PROBLEM AREAS
SCALE OF MILES
0 50 100
PROBLEM AREA
SUBREGION BOUNDARY
NC
NL
SB
SF
DC
SJ
TB
SL
CC
CD
SC
PACIFIC OCEAN
SACRAMENTO
San Francisco
Eureka
Redding
Klamath Falls
Bakersfield
Los Angeles
San Diego
NC NORTH COASTAL
SF SAN FRANCISCO BAY
CC CENTRAL COASTAL
SC SOUTH COASTAL
SB SACRAMENTO BASIN
DC DELTA-CENTRAL SIERRA
SJ SAN JOAQUIN BASIN
TB TULARE BASIN
NL NORTH LAHONTAN
SL SOUTH LAHONTAN
CD COLORADO DESERT

In 1965, Californians used more than 1.5 million acre-feet of water to recharge ground water basins: 900,000 acre-feet in the San Joaquin Valley, 425,000 acre-feet in the South Coastal Subregion, 145,000 acre-feet in the San Francisco Bay Subregion, and 50,000 acre-feet in the Central Coastal Subregion.

Flood Control. In the California Region, floodplains generally have been the first lands settled. As a result, these lands have been the scene of many flood disasters. Subsiding floods often have left damage, suffering, and death (Figure 6).

Recent destructive floods occurred in December 1955 and December 1964. The December 1955 floods exceeded most maximum flows of record for coastal streams north of Santa Barbara, for Central Valley streams, and for streams in the North Lahontan and in North Coastal Subregions. The floods inundated nearly one million acres, killed sixty-four persons and left property damages of about $170 million. The December 1964 floods left property damages of about $200 million. These floods struck North Coastal and Sacramento Basin Subregions, left thousands homeless, and killed twenty-four persons.

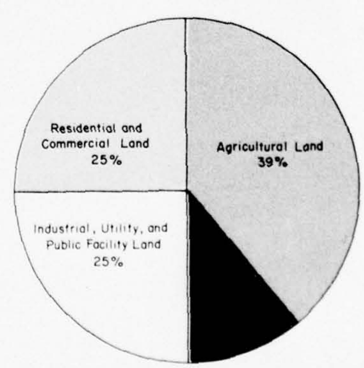
The residual average annual flood damage under 1965 conditions was about $107 million. Of this amount $56 million was in upstream damage and $51 million was in downstream damage*. Figure 7 provides the distribution of these damages among cities, industries, farms, etc.

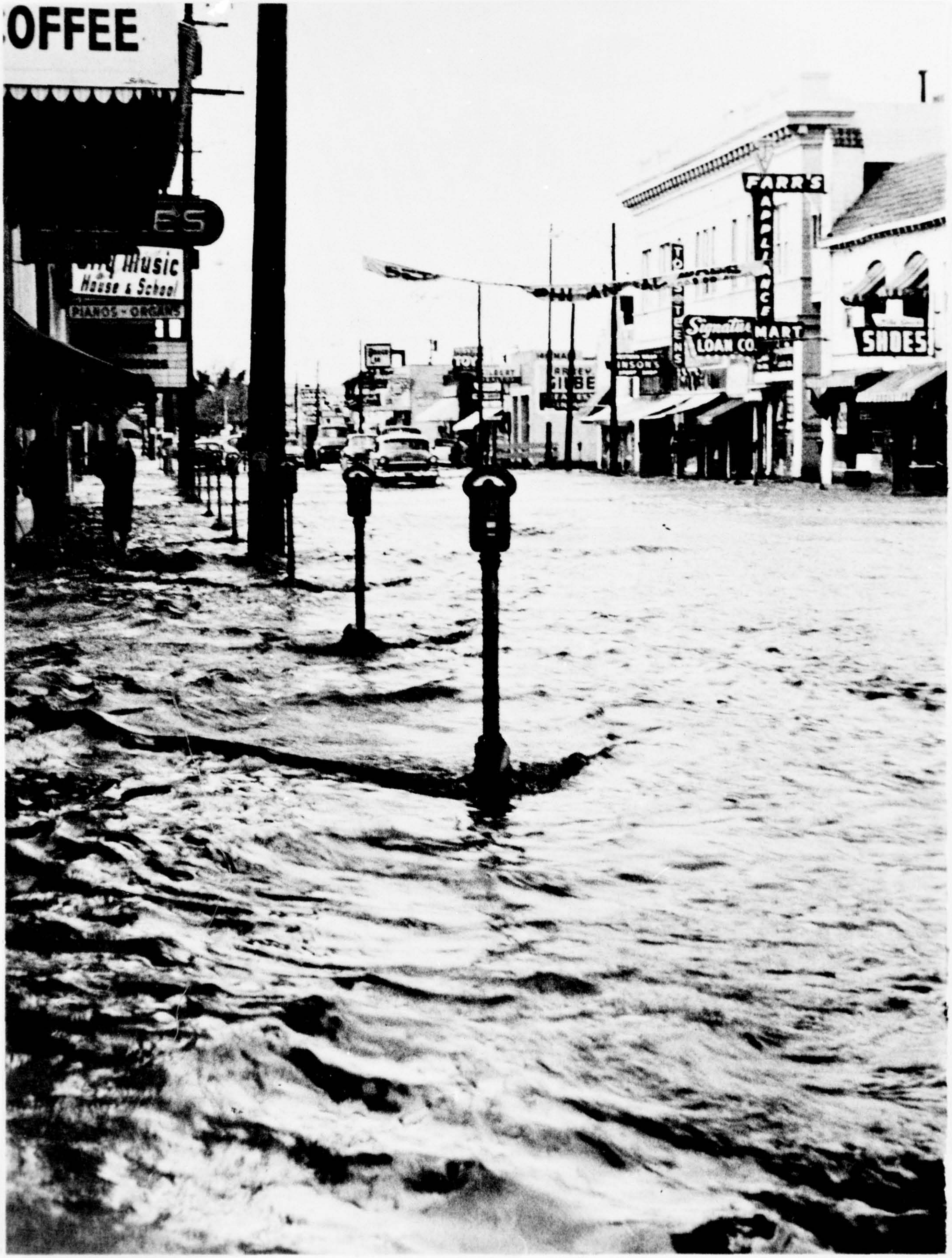
*Downstream damage is that which occurs below the point at which the drainage area equals 250,000 acres. The separation in no way determines the agency responsible for solution of the flood damage problems.

The Region's flood control and flood damage reduction program includes structural and non-structural measures of federal, state and local agencies. Structural measures include reservoirs, retardation structures, levees, and channel improvements. Non-structural measures include watershed treatment, flood forecasting, floodplain zoning, and flood proofing.

The existing flood control program in 1965 provided 5,915,000 acre-feet of flood control capacity in reservoirs and flood detention basins during the critical flood period. In 1965, more than 3,200 miles of levee and 2,900 miles of improved channel served an extensive levee, channel and bypass system of flood control. In the same

Figure 7 FLOOD DAMAGE DISTRIBUTION IN 1965




OFFEE
Music
House & School
PIANOS - ORGANS
FARR'S
APPLIANCE
MART
Signature
LOAN CO.
SHOES

year, radio and telephonic devices at more than 400 precipitation and stream gage data collection sites, together with telephoned or teletyped reports from public and private agencies and from cooperating observers, assisted in river and flood forecasts. In 1965, watershed treatment projects protected soil and vegetal cover on about 214,000 acres, thus increasing the water-holding capacity of soils, controlling runoff and reducing debris movement, erosion and sedimentation. The Federal Flood Plain Management Services Program provided flood hazard information to federal, state, and local governmental agencies. Such information guides proposals for future land development, suggests needs for land use regulation to avoid future flood damage, and assures that federal agencies will recognize the flood hazards associated with floodplain development.

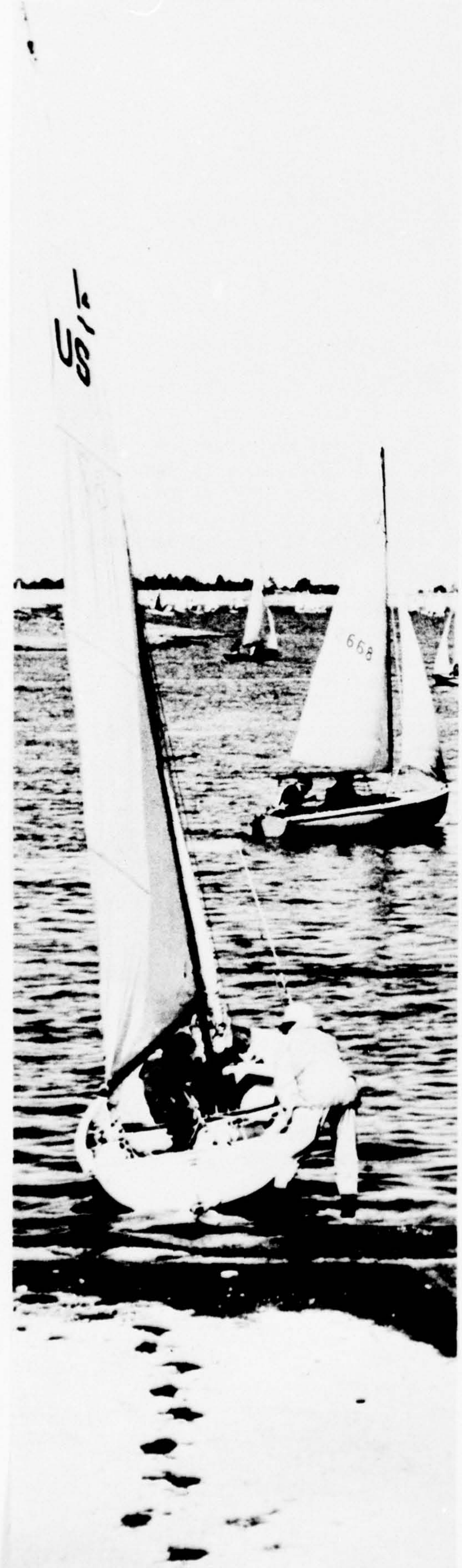
In both California and Oregon, the counties bear the responsibility of regulating land use and of zoning floodplains. Twenty-four counties in California regulate floodplains in some way. Of these, eight use floodplain zoning to regulate development.

Existing flood control measures prevented more than $270 million in damages during the December 1955 flood. Nine year later, existing measures prevented more than $340 million in damages.

Navigation. The navigable waters of the Region include the bays, estuaries and coastal waters of the Pacific Ocean to the west, the lower Colorado River to the southeast, and the streams and sloughs of the lower Sacramento and San Joaquin River systems.

In 1965, ports and waterways handled almost 100 million tons of waterborne commerce--eight percent of the total for the United States. Petroleum and its products comprised almost three quarters of the Regional total. Metals, chemicals, lumber, and agricultural produce contributed significantly to the remainder. In 1965, about 25 percent of the recreational boating in the Region was on its navigable waters.

The port complexes of San Francisco Bay, Los Angeles and Long Beach handle most commercial navigation in the Region.



Much of the rest passes through the harbors at Humboldt and Crescent City in the North Coastal Subregion and at Port Hueneme and San Diego in the South Coastal Subregion, and at Stockton and Sacramento in the Delta-Central Sierra Subregion. The Federal Government has dredged channels and built breakwaters and other works at many of these ports, and has authorized similar projects at the remainder. Petroleum terminals, privately owned, lie offshore the Central and South Coastal Subregions.

Existing facilities include 190 miles of channels and 820 acres of anchorage areas with depths of 30 to 50 feet; 24 miles of protective breakwaters and jetties; and terminal facilities at 320 wharves and on 3,600 acres devoted to handling cargo. Only minor requirements exist for the release of water stored behind state or federal dams so as to maintain river depths sufficient for ships. Although the Federal Government has authorized a minimum release of 4,000 cubic feet per second from Shasta Dam so as to maintain navigable depth in the Sacramento River, releases for other purposes generally maintain this minimum flow.

Recreational boats concentrate heavily in San Francisco Bay and along the San Francisco and Los Angeles coastlines.

Harbors and marinas for small craft, launching ramps for trailered boats, and moorings for transient boats cluster most thickly here. The lack of a chain of harbors of refuge along the coast severely constrains boating on the coastal waters and, particularly, intercoastal cruising.

Recreational boats berth at federally-funded marinas at Marina del Rey, Redondo Beach, King Harbor, Mission Bay Harbor, and Oceanside Harbor, all in the South Coastal Subregion. They berth at federal, state, county, city or private marinas along the coast, in San Francisco Bay, or along the Sacramento, San Joaquin or Colorado Rivers.

Federal funding at such marinas applies to breakwaters, jetties, channels, and anchorage areas, but not to docks. In 1965, the Region provided 7,900 moorings for transient boats; it could have used an additional 1,300 moorings. It provided 41,000 berths for small craft and could have used an additional 10,300 berths. It provided 760 launching lanes and hoists to handle trailered boats.

Land Development

In 1965, fifty-two percent of the Region's land was privately owned. Private ownership included nearly all the land suited to intensive agriculture (nearly 40 percent of such ownership) as well as nearly all that suited to urban and industrial development. It included about 50 percent of the land

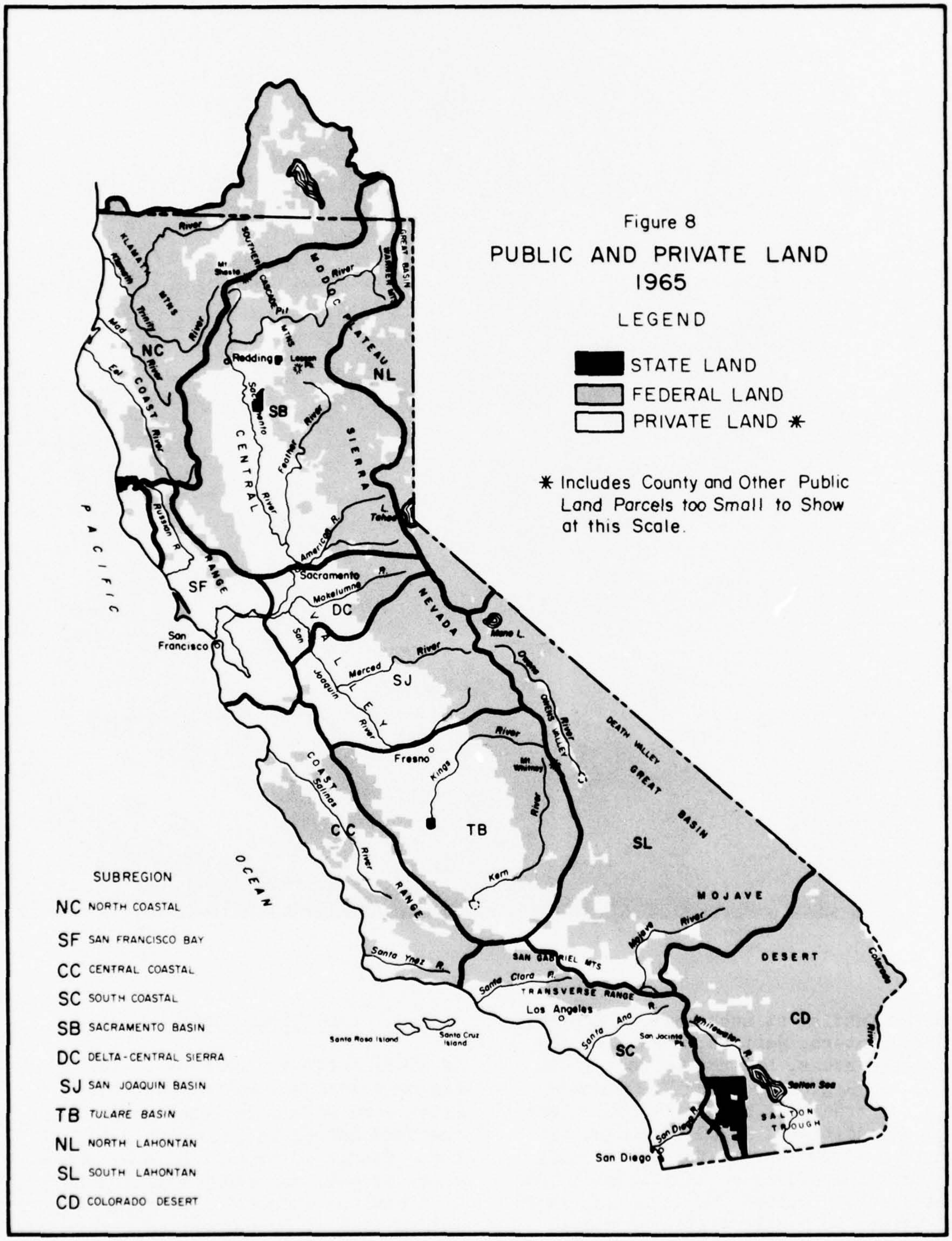


Figure 8
PUBLIC AND PRIVATE LAND
1965

suited to timber production and about 62 percent of that suited to grazing.

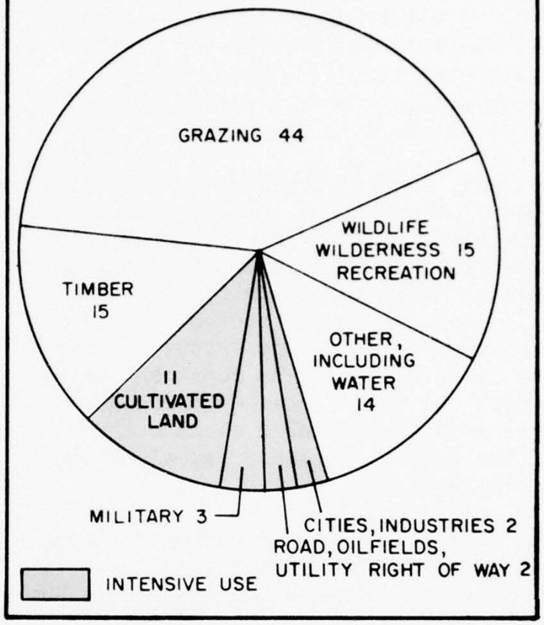
In 1965, forty-four percent of the Region's land was federally owned. The Forest Services administers 44 percent of this land: the national forests, lying generally in the mountainous areas of the Region. The Bureau of Land Management administers 37 percent of the land, most of which lies in mountain foothills and deserts. Both agencies manage their lands under multiple-use concepts. The National Park Service administers an additional 9 percent of the federal land: parks covering desert, seashore, foothill, and high-mountain areas. The Defense Department administers 6 percent of the land, mostly desert. In addition, the Defense Department, the Bureau of Reclamation, the Fish and Wildlife Service, and the California Department of Fish and Game and the Oregon State Game Commission possess secondary administrative responsibilities on lands whose primary administration lies with other federal agencies (Figure 8).

In 1965, two percent of the Region's land was state owned. The final two percent of the land was owned by cities and counties, mostly in parks and roads, and by school, water, and irrigation districts, etc.

In comparison to total acreage, that acreage developed for intensive use after a hundred years of settlement in the Region is quite small. Cities occupy two percent of the Region; roads, oil fields, and utility rights-of-way, another two percent; military bases, three percent; and cultivated land, 11 percent--two-thirds of which is irrigated. Together these uses occupy only 18 percent of the Region (Figure 9).

Most of the Region, including both cities and deserts, supports some sort of wildlife. The floodplains, always attractive to mankind, have been the first lands settled and developed. And, although they have witnessed many disasterous floods, the developments continue to increase.

Figure 9: LAND USE 1965
(In 1,000,000 Acres)



The present pattern of land ownership and administration reflects past policies of the Federal Government in its efforts to settle the West: the Homestead, Timber, and Stone Acts, mining laws, and land grants to states, railroads, and individuals, effectively lured people and industry into the West.

Although major transfers of ownership occurred during the 19th and early 20th centuries, exchanges of public and private lands continue into the present.

Shoreline. Including the almost 300 miles of shore which skirts San Francisco Bay, and the almost 400 miles which circle eight Channel Islands, the ocean shoreline of the Region extends more than 1,700 miles. Three-quarters of the people in the Region live within an hour's drive of some portion of this shoreline.

In 1965, cities, farms, and forests occupied about 1,000 miles of the shoreline zone, a strip of land about 500 feet wide which includes the land subject to sea erosion. Harbors, military and other areas occupied the remainder. About 600 miles of shoreline lay under public control, about half of it by the Federal Government.

In 1965, about 300 miles of publicly controlled area was open to recreation: one-third of it to scenic shoreline, another third to swimming beaches, and a final third to public beaches too cold, too dangerous, or too rocky for swimming. Most of the latter beaches lay along the northern coast and were subject to unfavorable exposure as well as to unfavorable climate. Most of the swimming beaches lay along the southern coast.

The desire to swim and sunbathe attracted most visitors to the shoreline. In addition to swimmers and sunbathers however, the shoreline areas accommodated surfers, scuba divers, free divers, fishermen, shellfishing enthusiasts, picnickers, campers, driftwood collectors, rock collectors, walkers, wildlife watchers, tidepool explorers, and motorists.

In 1965, swimming along the shoreline accounted for 53 million recreation days of use. Shoreline fishing accounted for an estimated four million recreation days of use. Other activities accounted for an additional 13 million recreation days of use.

Erosion critically threatens almost 300 of the 1,100 shoreline miles it actively affects. More than 60 percent of the threatened areas lie in the South Coastal Subregion, most of them adjacent to highways and railroads, or along popular swimming beaches. In 1965, average annual erosion damages reached an estimated $9,900,000. Measures taken to fight such erosion include artificially-widened protective beaches, stabilizing groins, revetments, seawalls, offshore breakwaters and sand bypassing and sand replenishment systems.

By 1965, the Federal and State Governments had built 11 miles of stabilization works and one mile of seawall, and had replenished 14 miles of beach. All but one mile of these works lay in the South Coastal Subregion. Counties and cities built groins, revetments and seawalls, and placed beach fill. For the most part, private measures taken for shoreline protection were temporary.

<u>Minerals</u>. Of the $1.6 billion in minerals produced in the Region in 1965, mineral fuels represented about 64 percent; nonmetals, 32 percent; and metals,

4 percent. Although the value of mineral output is low in comparison to the total regional product, mines provide basic raw materials for other industrial and trade activities. Petroleum and natural gas provide most of the energy needed to manufacture and transport goods, to light the cities, to pump municipal water and to dispose of municipal waste waters. Cement, sand, and gravel provide material for the buildings and roads required by 18 million people.

Irrigation and Drainage. In 1965, in the Region, 8,435,000 irrigated acres produced 8,765,000 acres of crops. The additional 330,000 acres of crops represents double cropping. Production of these crops required delivery of 29,780,000 acre-feet of water to farm headgates. Pasture accounted for 1,551,000 acres--18 percent--of the irrigated acreage. Alfalfa accounted for 1,415,000 acres; deciduous, vineyard, and subtropical crops, for 1,207,000 acres; miscellaneous truck crops, for 907,000 acres; miscellaneous field crops, for 849,000 acres; hay and grain, for 843,000 acres; cotton, for 740,000 acres; and rice, sugar beets, and citrus, for 923,000 acres.

Reservoirs and ground water provide most of the water used to irrigate crops in the Region, although diversions direct from the stream are numerous. More than 260 state and county water districts in the Region provide water to more than half the irrigated acreage.

In 1965, surface drainage problems affected about 764,000 acres; subsurface drainage problems, about 1,517,000 acres.

Recreation. California residents seek 70 percent of their recreation within a one-hour travel radius.

Most nonurban recreation occurs at national, state and county parks, at developed recreation areas on the public domain at wildlife refuges, on military lands, at historic sites and at private resorts generally close to inland or ocean waters. The Region contains 13 national parks and 22 national forests.

Fish and Wildlife. The Region provides a wide range of biotic communities both on its public and private lands and on its waters. Millions of waterfowl cross the Region along its Pacific Flyway. Ten million waterfowl have been known to winter in the Region. Important waterfowl areas lie along the coast and within interior valleys from the Klamath Basin to the Salton Sea.

Game is widely distributed. In 1965, hunters provided almost 10 million hunter-days of use within the Region. Forty-seven percent of this time was spent in pursuit of upland game; 38 percent, in pursuit of big game; and 15 percent, in

pursuit of waterfowl. Nature studies, wildlife photography, and bird watching occupied more than 14 million days.

Fishermen provided about 24 million angler days of use, almost 80 percent of which occurred in inland waters; and the remainder, in bays and the ocean. Inland fisherman sought trout, striped bass, sturgeon, salmon, steelhead, shad, and warm-water fish. Bay and ocean fishermen also sought striped bass, sturgeon, salmon, steelhead, and shad.

Twenty-five state and federal fish hatcheries operated in 1965, together with seven research stations and laboratories. State and federal fish and game agencies operated 33 wildlife management areas. Many of these permitted the hunting of waterfowl. Others provided winter range for big game and year-round habitat for upland game. Public fish and game agencies owned or operated 392,000 acres of wildlife areas. Public agencies managed wildlife on 426,000 acres of military land. Miscellaneous refuges established by legislative action occupied about 4,500,000 acres. The largest such refuge, occupying 3.6 million acres, provided protection for the wild burro.

Commercial fishermen landed 433 million pounds of fish. This catch has been valued at $50 million. About a fourth was taken from bay and inshore marine areas; the rest, from the sea.

In 1965, the catch of trapped fur animals in California was valued at more than $100,000.

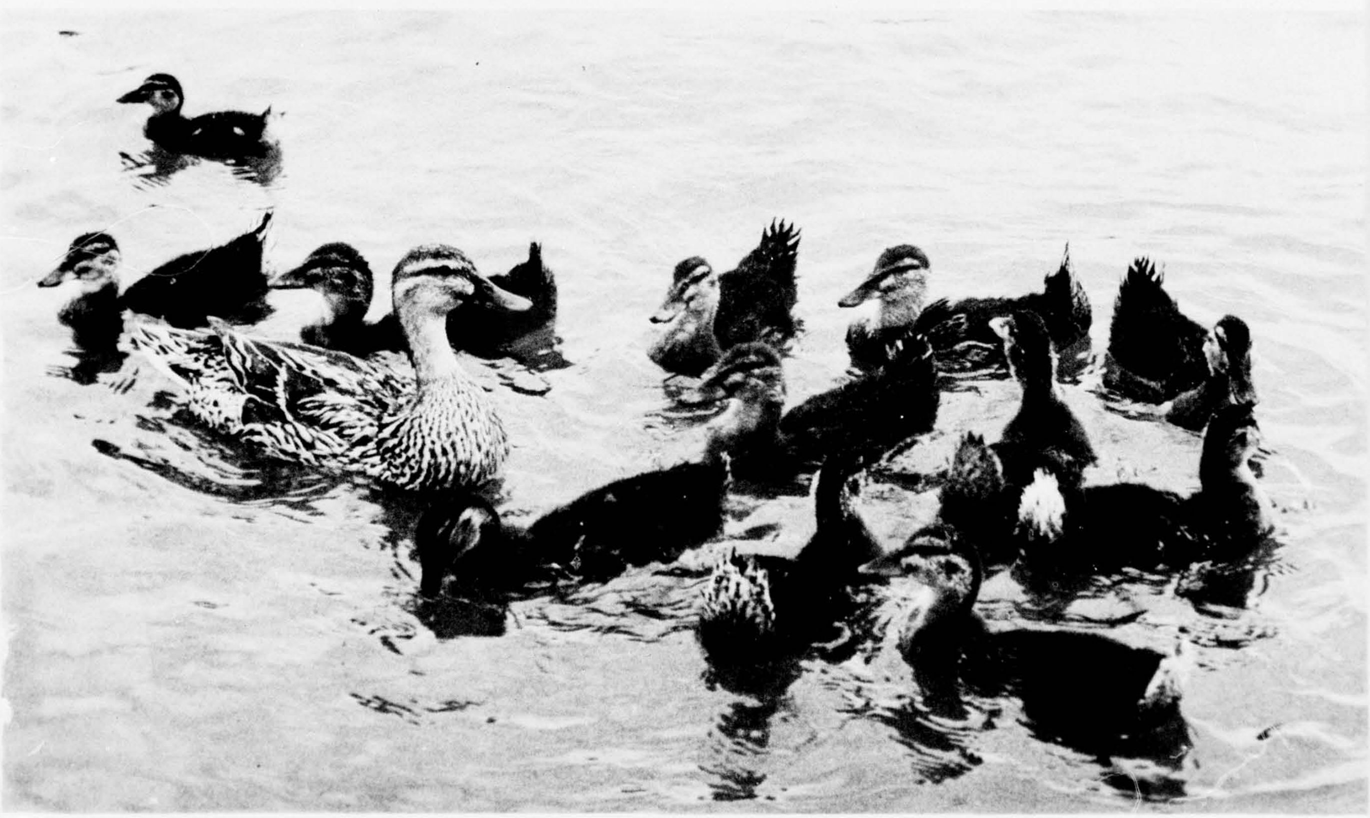
Electric Power. The principal industrial developments of the Region lie where sources of energy are readily available. Thus, major industries center in both the Los Angeles and the San Francisco Bay area. Improvements in transportation of coal, oil and gas will make future locations much more flexible than those of the past. At

present, the high cost of transporting both coal and coke has restricted their use in the Region.

The structure of energy supply in the Region contrasts with that in other major regions of the United States. Petroleum and natural gas have provided the basic energy for this Region. Water power has provided that for the Northwest; natural gas, that for the Southwest; and coal, that for the remainder of the country.

In 1965, the Region possessed a dependable capacity of 20,480 megawatts and produced about 96 billion kilowatt hours of electricity. Natural gas provided fifty-nine percent of this energy; oil, 17 percent; hydroelectric plants, 23.5 percent; and nuclear fuel, .5 percent.

A 230 kilovolt grid, passing generally from north to south, transported most of the energy. The lines extending from this grid ranged in capacity from 11 to 287 kilovolts. In 1965, transmission lines of 115 kilovolts and more required estimated rights-of-way totaling 192,000 acres.



Part IV:

WATER AND RELATED LAND RESOURCES AVAILABILITY

About 23 inches of rain and snow fall on the Region annually. Of this average, only eight inches runs off. The rest either evaporates or evapotranspirates into the atmosphere or percolates into ground water basins. The eight inches of precipitation resulted in an average of 70 million acre-feet of natural runoff* annually for base period 1931-60.

Surface Water

Geographical distribution, among the subregions, of precipitation and natural runoff for the period appears in Table 1 together with the runoff remaining with 1965 conditions of water development.

Water developments are designed not to serve average years but to cope with winter floods and summer droughts, with years of high runoff and years of low runoff. Both rain and snow feed the streams of the region. The rain-fed streams rise and fall rapidly with winter storms. The snowfed streams rise in the spring or early summer and fall in the later summer. All streams have diminished by later summer.

Streamflow varies not only by season but by year. In the period between 1931 and 1960, annual runoff varied between 16 million acre-feet in 1931 and 113 million acre-feet in 1958; the annual average for this period was 56 million acre-feet.**

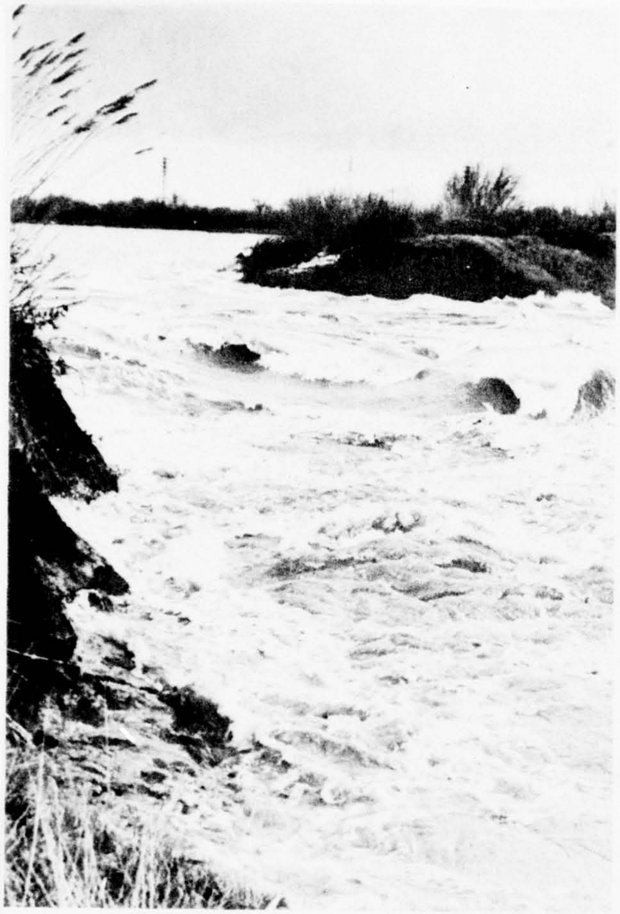
* Natural runoff is that runoff which would occur were no water developments storing and using water.

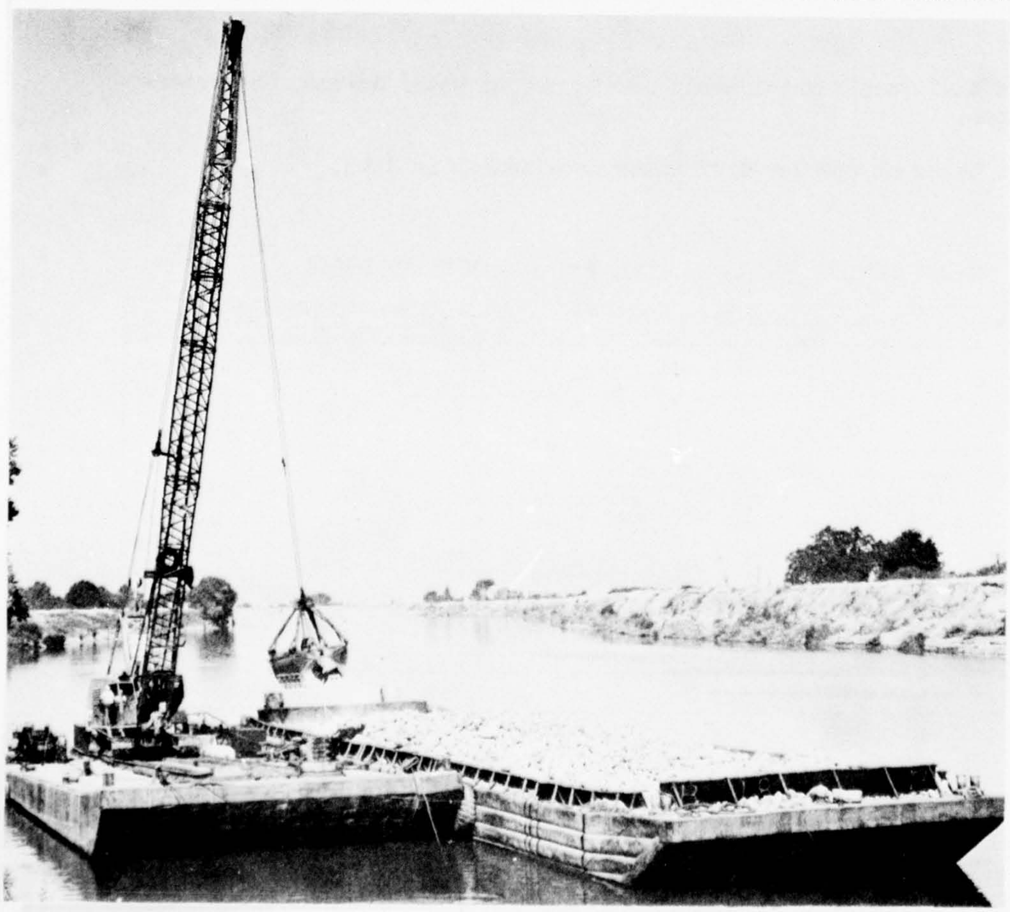
**These figures are based on the level of water development in 1965.

Table 1: MEAN ANNUAL PRECIPITATION AND RUNOFF: 1931-1960

Subregion	Area, in square miles			Precipitation, in inches			Runoff, in inches			Runoff, in 1,000,000 acre-feet					
							Natural			Natural			1965 conditions		
	California	Oregon	Region	California	Oregon	Region	California	Oregon	Region	California	Oregon	Region	California	Oregon	Region
North Coastal	17,710	5,710	23,420	51.4	26.0	45.2	28.6	7.5	23.5	27.1	2.2	29.3	25.3	2.1	27.4
San Francisco Bay	6,110	-	6,110	-	-	30.0	-	-	10.3	3.3	-	3.3	3.1	-	3.1
Central Coastal	11,450	-	11,450	-	-	19.8	-	-	2.9	1.8	-	1.8	1.1	-	1.1
South Coastal	10,980	-	10,980	-	-	18.4	-	-	2.4	1.4	-	1.4	.4	-	.4
Sacramento Basin	26,500	720	27,220	36.0	22.0	35.6	14.9	4.4	14.6	21.1	.2	21.3	18.6	.2	18.8
Delta-Central Sierra	4,950	-	4,950	-	-	24.8	-	-	4.1	1.1	-	1.1	-2.7*	-	-2.7*
San Joaquin Basin	11,060	-	11,060	-	-	28.4	-	-	10.3	6.1	-	6.1	2.6	-	2.6
Tulare Basin	17,390	-	17,390	-	-	15.4	-	-	3.4	3.1	-	3.1	3.1	-	3.1
North Lahonton	6,080	-	6,080	-	-	22.1	-	-	4.7	1.5	-	1.5	1.3	-	1.3
South Lahonton	27,050	-	27,050	-	-	7.9	-	-	.8	1.2	-	1.2	.7	-	.7
Colorado Desert	19,410	-	19,410	-	-	5.5	-	-	.11	.1	-	.1	.1	-	.1
REGION	158,690	6,430	165,120	22.9	25.6	23.0	8.0	7.2	8.0	67.8	2.4	70.2	53.6	2.3	55.9

*1965 demands exceed natural runoff; excess supplied from Sacramento Basin






Floods represent one runoff extreme. At least ten major floods have struck the Region since 1950.

Ground Water

Ground waters lie in the sedimentary fill of more than 250 ground water basins scattered through the Region. Most of the usable ground waters however, lie in the Sacramento and San Joaquin Valleys, where wells supply extensive irrigation.

In 1965, pumps supplied about 15 million acre-feet of ground water: two million for cities and industry, and 13 million for agriculture. The safe annual yield of the ground water basins under 1965 conditions is an estimated 11.5 million acre-feet. Several areas have exceeded this safe yield, notably the southern San Joaquin Valley, the Southern California coastal plain, and the Antelope Valley of Southern California. The result is an overdraft of about 3.5 million acre-feet.

Water Quality

Because its northern streams flow copiously and perennially, and because many of its southern streams flow only intermittently, the Region practices varied techniques of waste water disposal. To the south, far more frequently than to the north, waste water is used to recharge ground water basins lying beneath floodplains and dry river beds. To the north, such waste water is discharged into rivers.

The quality of the Region's waters is adequate for most uses. Although reservoirs have altered the relationship between low, average and flood flows throughout the Region, the most dramatic alterations have occurred in the Central Valley and to the south. In some cases, releases from such reservoirs sustain higher base flows. In other cases, the reservoirs have increased the frequency of low flows and thus have affected adversely the ability of a given stream to absorb waste water to the degree necessary. This ability varies not only as a function of flow, but also as a function of locale and of intended water use. That quantity and concentration of waste constituents which would harm Lake Tahoe would affect the Salinas or the San Joaquin Rivers only insignificantly.

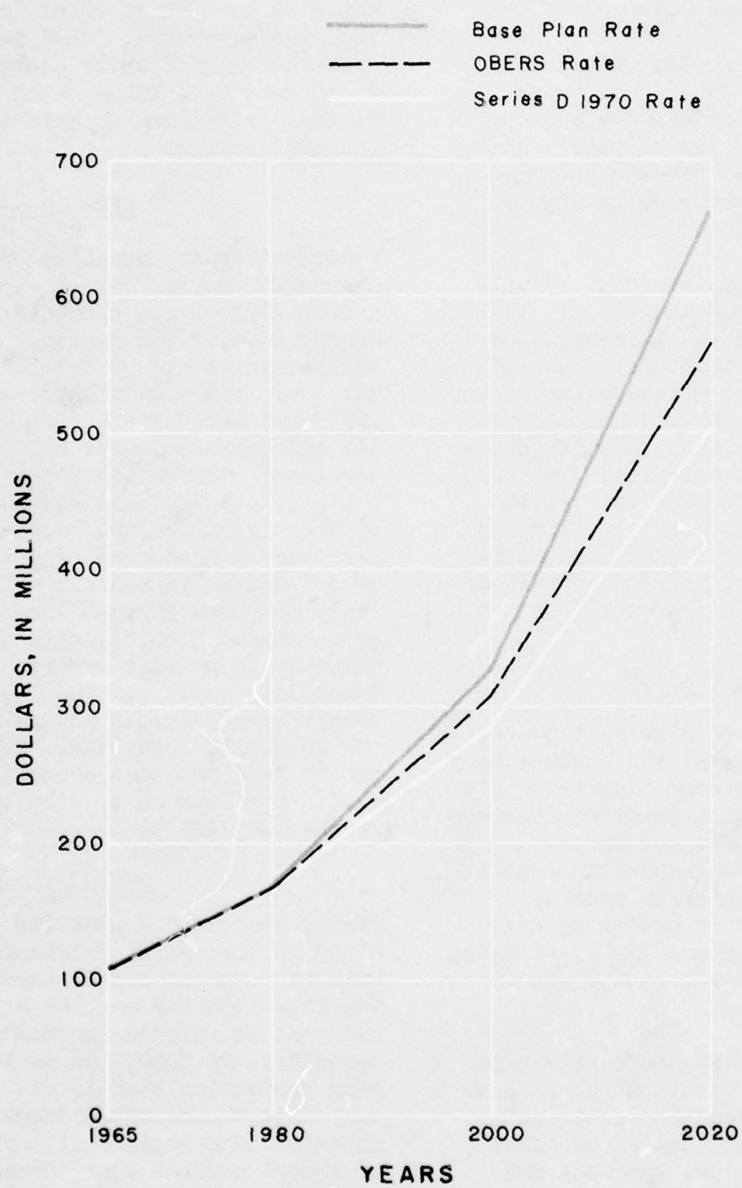
Land

Rangeland grass, broadleaved herbs, chaparral, brush, desert vegetation, and coniferous and hardwood forests occupy most of the Region. About 21 million acres are suited to timber production: about 24 million acres to irrigated agricultural production. Public and private owners hold almost equal acreages. The United States Government, which originally held about 90 percent of the Region in public ownership (the rest having been granted to private owners under Spanish and Mexican rule), early disposed of most lands suited to agriculture, grazing, cities, and industry to private owners. Forested mountains, brush covered foothills, and desert comprise most of the lands remaining to public ownership. Much of this public land provides areas crucially needed for fisheries, wildlife habitat, recreation, and timber.

Minerals

Stone, sand, and gravel for construction, although they exist in quantity, probably will be in short supply throughout the San Francisco Bay and Los Angeles areas, and will be shipped in from more distant deposits. By 2020, the decline of petroleum production to half its 1965 level will have necessitated domestic or foreign imports. The Region will need to continue to import natural gas: demand has exceeded production since 1947. Reserves of salt, boron, and sodium compounds are expected to suffice for 100 years. Metal production is expected to double.

Figure 10: FLOOD DAMAGE*



*1965 Price Levels and 1965 Flood Control Measures Without Additional Flood Control Measures.

Part V: PROBLEMS AND NEEDS

This study assumes a growth of population and economy which will create a growth in the need for goods and services. Appendix XVIII summarizes the methods used to translate population projections into projections of needs.

Flood Control

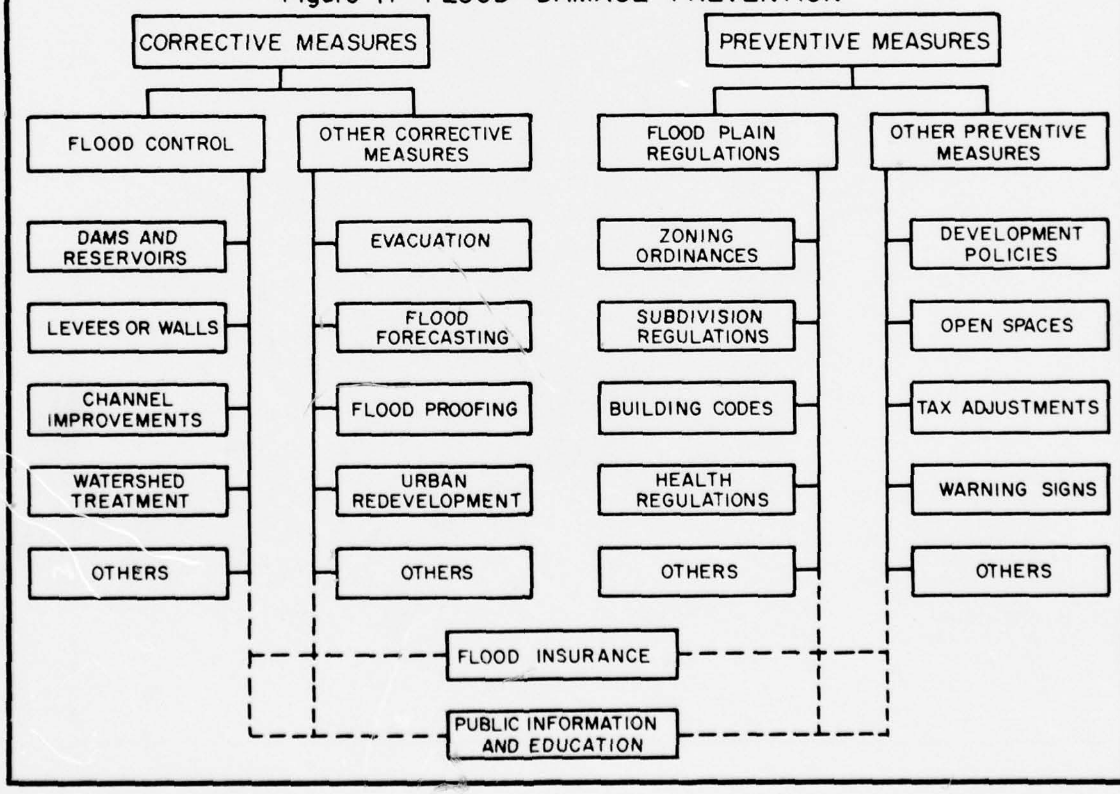
Average annual flood damages estimated for 1965, 1980, 2000, and 2020 illustrate the magnitude of the need for a future program of flood control (Figure 10).

The Region must reduce flood damage to a reasonable level by further controlling floodflows and by acting to reduce their damaging effects. Agricultural areas should receive protection from the once-in-10 to the once-in-50 year flood; urban areas, from the once-in-100 year flood to the standard project flood.

Figure 11 suggests a comprehensive flood damage prevention program.

Flood control prevents property damage, human suffering, and the loss of life, goods and services. Although existing flood control measures afford a high degree of flood protection, problems still exist. Floodplain lands, for example, are ideally located for residential, commercial, industrial and agricultural development. But as the use of floodplain lands increases, and as intensive development of watershed areas results in increase runoff, flood damage to floodplain lands will increase.

Figure 11: FLOOD DAMAGE PREVENTION



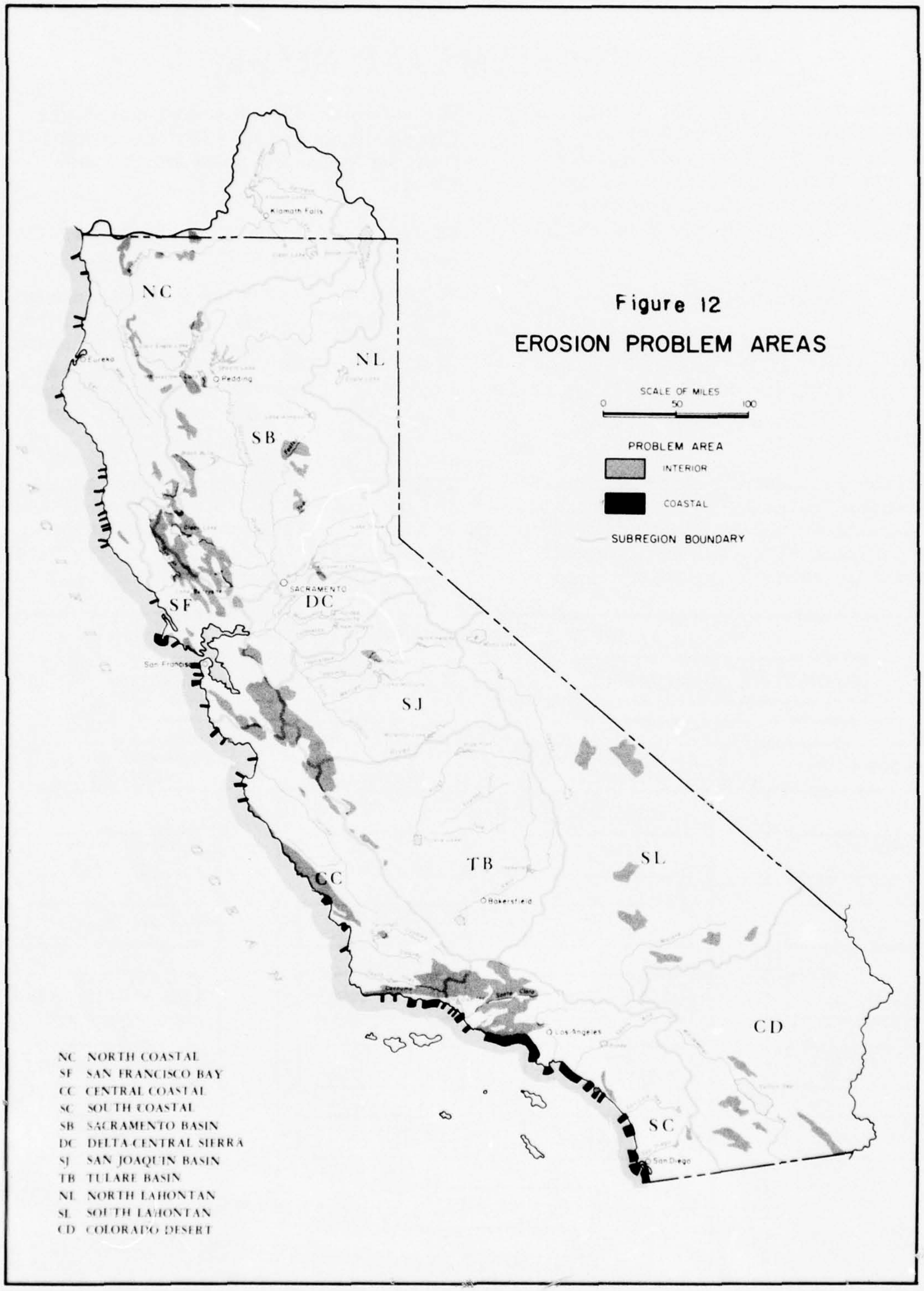


Figure 12
EROSION PROBLEM AREAS

Watershed Management

Problems of watershed management include those of erosion, sedimentation, flooding, and wildfire. Vegetative management to reduce water use and increase snow accumulation would increase runoff, water quality, and water yields.

In 1965 more than 44 million acres within the Region possessed the potential for moderate or severe erosion. An estimated 21,200,000 acres suffered from active erosion. Specific watershed management programs could resolve problems of active erosion on 7,200,000 of these acres. Proper management of croplands, forage, and timber production could resolve such problems on the remaining acreage (Figure 12).

Unless additional fire prevention and suppression programs are provided for 64 million acres, however, wildfire damage in 2020 will exceed that of 1965 by 250 percent.

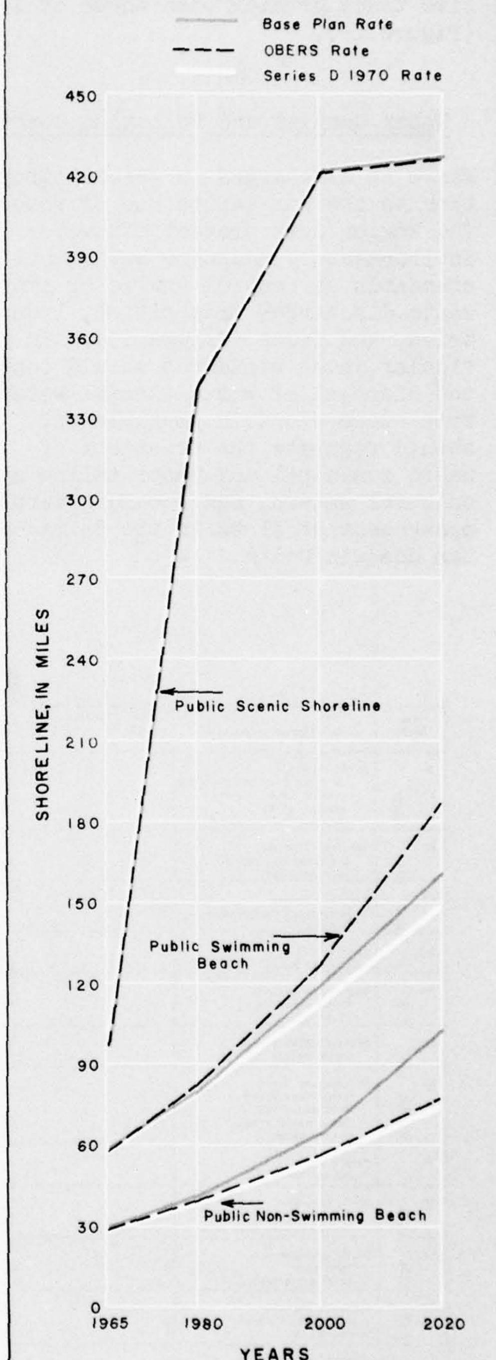
Shoreline

Within its shoreline zone, the Region must reduce the potential for erosion (Figure 12), must meet the need for beaches, and must conserve its scenic shoreline.

In 1965, public beaches and scenic shoreline proved generally adequate to meet Regional needs, although some beaches near large cities proved deficient and urban encroachment threatened some reaches of scenic shoreline.

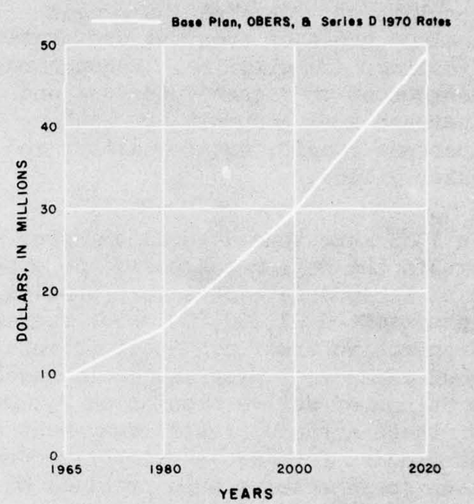
Figure 13 presents projected needs for public recreational shoreline. Shoreline areas must include appropriate provisions for fishing, for picnicking, for tide-pool exploration, for nature study, for camping in the uplands adjacent to the beaches, for parking and for access to the beaches.

Figure 13
SHORELINE RECREATION NEEDS



About one-fourth of the mainland shoreline suffers critically from erosion. Erosion damages in 2020 will be almost five times greater than those of 1965 (Figure 14).

Figure 14: SHORELINE EROSION DAMAGE*
(1965 Price Levels)



*Without Additional Shoreline Protection Measures

Water Quality and Pollution Control

Waste is discharged in general proportion to the per capita use of water. The Region must protect its water environment by adopting water quality standards to control unwise or improper waste discharges from cities, industries, and farms (Figure 15). In particular, such standards should control the disposal of waste thermal waters from steam electric powerplants, should regulate the treatment of waste municipal and waste saline agricultural waters, and should govern the management of flows in the Sacramento-San Joaquin Delta.

INDEX TO Figure 15

Map Symbol	Subregions & Location	Fish Kills	Stench	Waste Discharges						Eutrophication		Salinity			Turbidity, Siltation, Erosion
				Bacterial	Oil	Mines	Cities & Industries	Ships	Farms	Algae Bloom	Oxygen Drop	Sea Intrusion	TDS* High	Nitrates High	
NC	North Coastal														
1	Crescent City-Humboldt Bay			X			X	X							
2	Klamath Lake		X						X	X	X				
3	Klamath River	X								X					
4	Drainage Basins (Most)														X
SF	San Francisco Bay														
5	San Francisco Bay	X	X	X	X		X			X	X				
6	Russian River						X			X					X
CC	Central Coastal														
7	Monterey & Carmel Bays				X		X					x			
8	Streams						X		X	X					
SC	South Coastal														
9	Coastal Areas		X	X			X	X	X	X	X				
SB	Sacramento Basin														
10	Keswick Reservoir	X				X									
11	Clear Lake									X					
DC	Delta-Central Sierra														
12	Delta System						X		X		X		X		X
SJ	San Joaquin Basin														
13	Stanislaus River	X					X		X	X			X	X	
14	Tuolumne River	X					X		X	X			X	X	
15	San Joaquin River	X					X		X	X			X	X	
16	Ground Water												X		
TB	Tulare Basin														
17	Ground Water								X				X	X	
NL	North Lahontan														
18	Lake Tahoe						X								X
19	Carson River, East Fork					X									
SL	South Lahontan														
20	Mono Lake												X		
21	Recreation Areas			X											
CD	Colorado Desert														
22	Agricultural Areas												X		
23	Salton Sea	X					X		X	X	X		X		

* Total dissolved solids

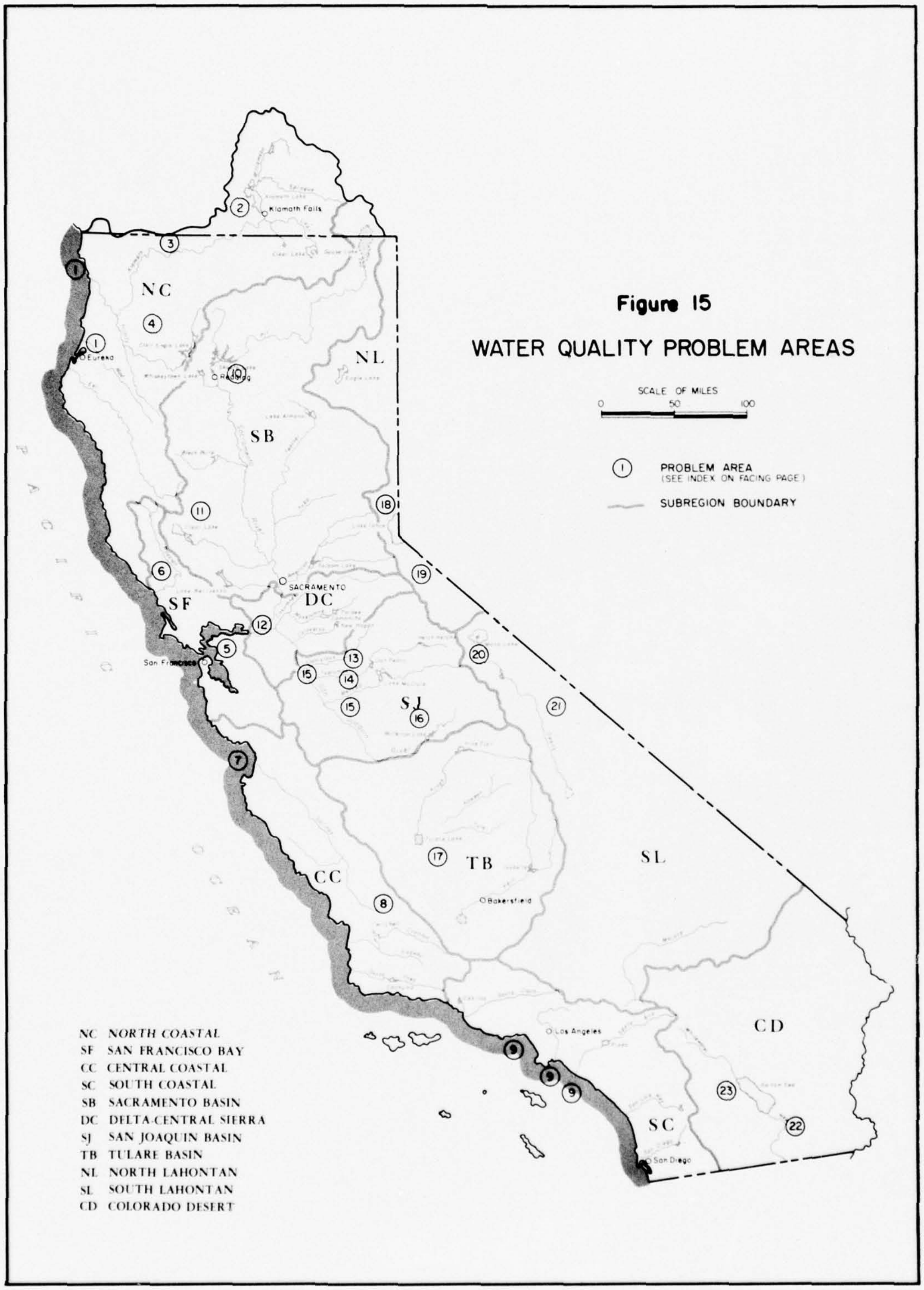
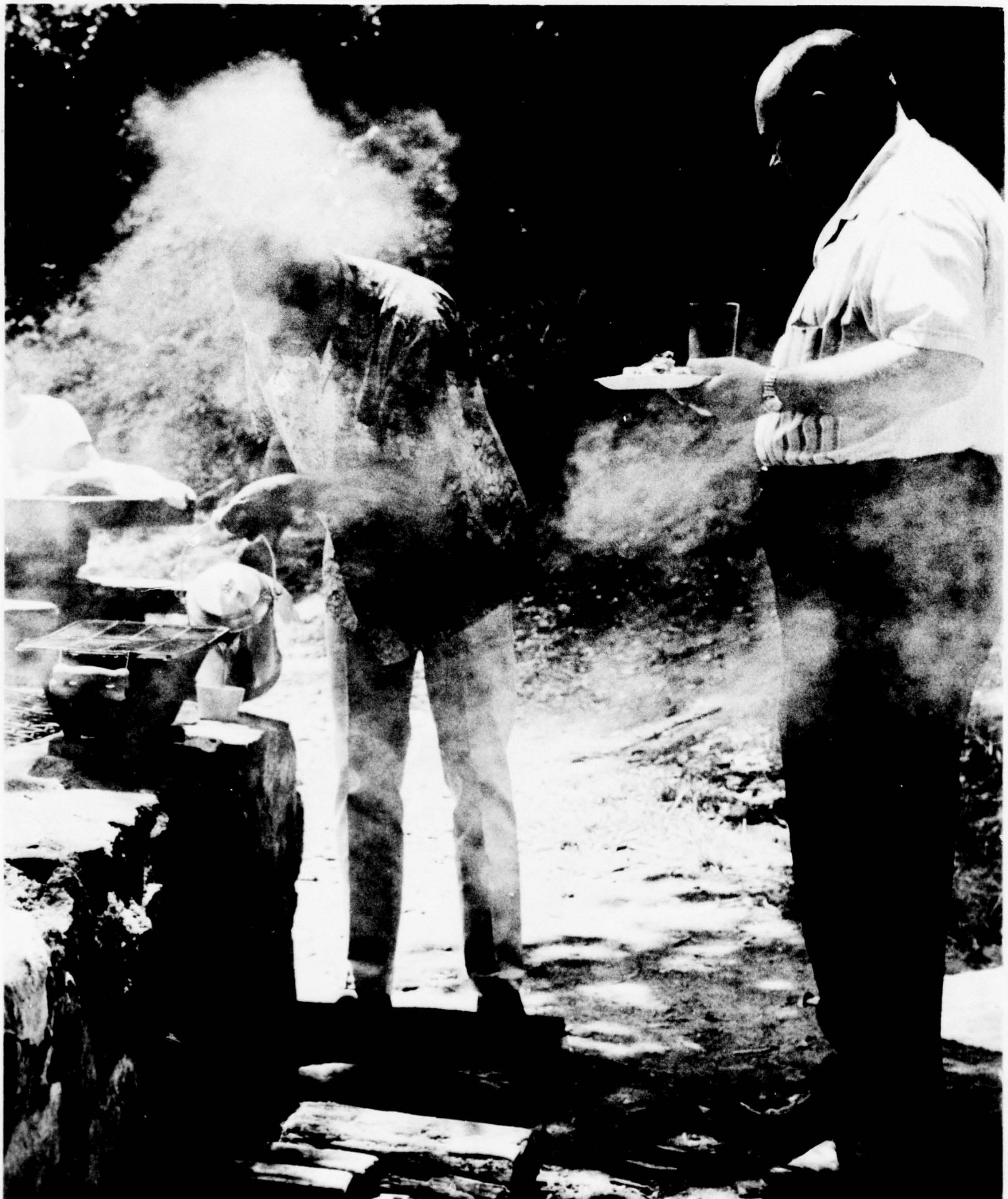


Figure 15
WATER QUALITY PROBLEM AREAS
SCALE OF MILES
0 50 100
PROBLEM AREA
(SEE INDEX ON FACING PAGE)
SUBREGION BOUNDARY
NC NORTH COASTAL
SF SAN FRANCISCO BAY
CC CENTRAL COASTAL
SC SOUTH COASTAL
SB SACRAMENTO BASIN
DC DELTA-CENTRAL SIERRA
SJ SAN JOAQUIN BASIN
TB TULARE BASIN
NL NORTH LAHONTAN
SL SOUTH LAHONTAN
CD COLORADO DESERT
Klamath Falls
Eureka
SACRAMENTO
San Francisco
Bakersfield
Los Angeles
San Diego



Recreation

The demand for outdoor recreational facilities in 2020 will be three times that of 1965 (Figure 16). By 2020, for example, the Region will need an additional 187,000 acres of flatwater surface, most of it as near to cities as possible.

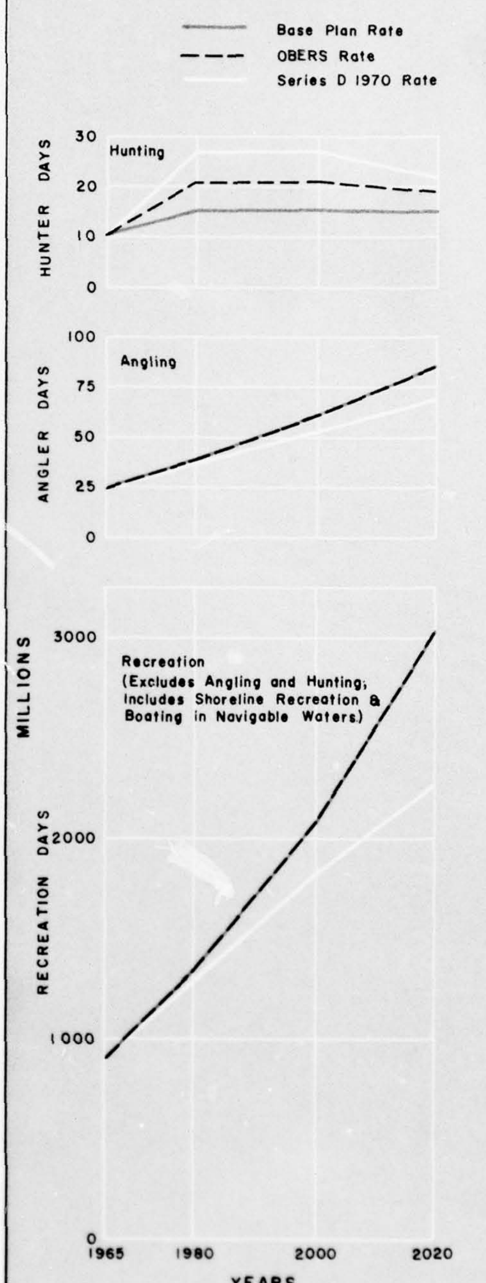
Unmet needs will grow. Almost 95 percent of the unmet needs for outdoor recreational facilities in 1965 was for city parks and playgrounds. The local and state governments that must meet such needs probably will continue to be least financially able to do so. Thus, all levels of government must coordinate their efforts so as to gain the recreational goals of each level.

The Region must emphasize the preservation of its wilderness, open spaces, and historical and archeological sites. Already, growing cities, impounded waters, and concrete channels have altered many stream reaches. Developments proposed for many of the remaining reaches would alter them also. Furthermore, the number of campers and off-road vehicles will increase. Thus, natural areas will not remain available for future generations unless the Region rates its social and environmental values equally with its economic values. It must limit the recreational uses of wild areas to those which will not harm the areas. It must provide facilities in developed areas to accommodate all forms of recreation.

Fish and Wildlife

Time spent in hunting and fishing in 2020 will be about three times that spent in 1965 (Figure 16). To provide the proper habitat for fish and wildlife and needed isolation for fishermen, hunters, and wildlife lovers, the Region will have to set aside more than one million additional acres of land, and more than one million additional acre-feet of water. The estimate for water, most

Figure 16: RECREATION NEEDS



of which would serve waterfowl areas, does not include water used instream.

The Region must preserve its wilderness and estuarine areas, as these support many forms of fish and wildlife. It particularly must preserve its endangered and rare species of fish and wildlife. An endangered species is one whose present prospects

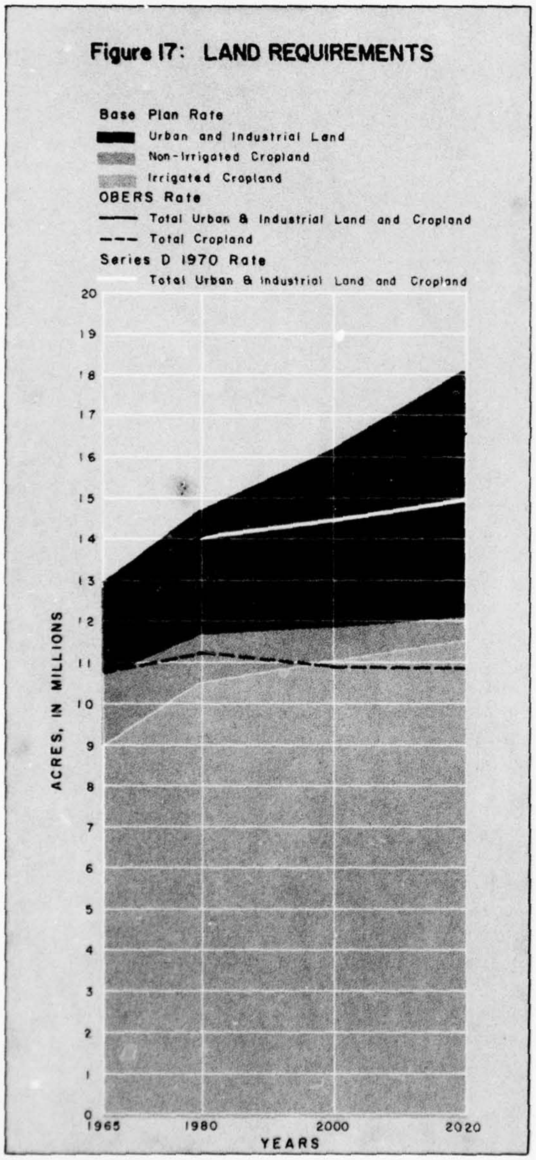
for survival are jeopardized; a rare species is one whose numbers are few throughout its range. In 1968, the U. S. Bureau of Sports Fisheries and Wildlife listed 26 species in the Region as endangered; it listed 10 species as rare.

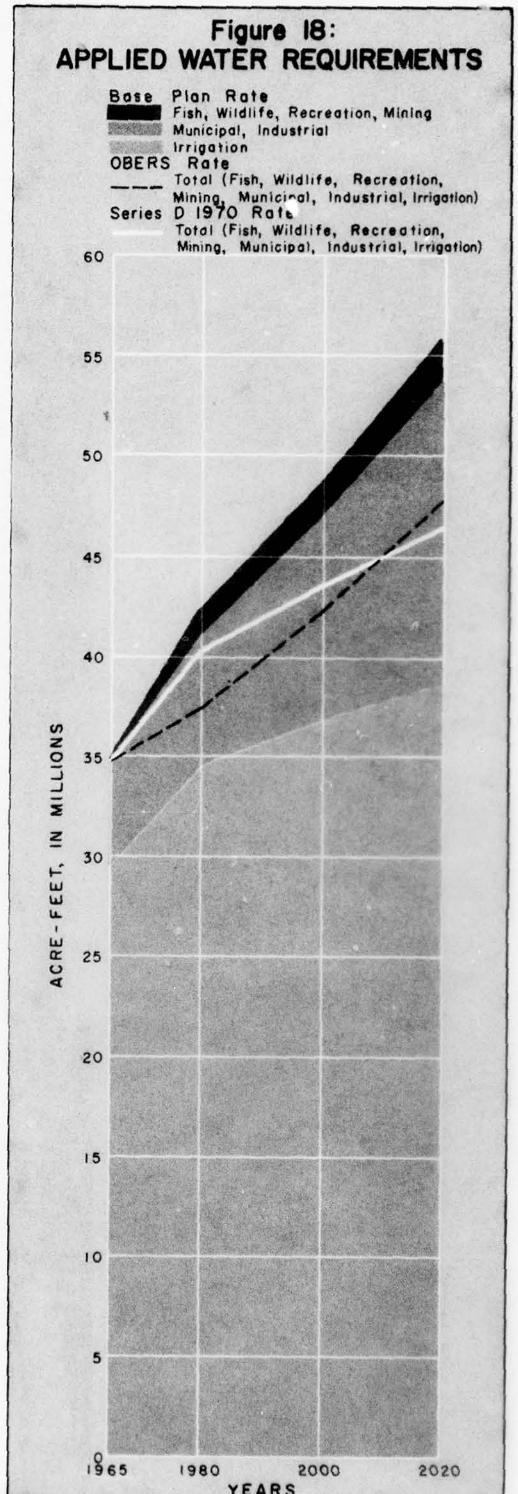
Land and Water

Figures 17 and 18 show the expected increase in requirements for land and water.

Irrigated cropland will increase and

non-irrigated cropland, decrease. Estimates assume that yields per acre per crop will increase by 27 to 140 percent between 1965 and 2020. They assume an average increase of 81 percent. Such increased yields will reduce the irrigation requirement in





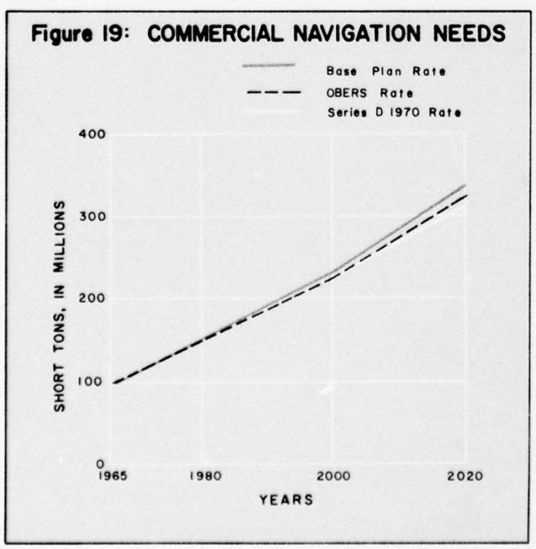
2020 by more than 30 million acre-feet from that which would have been required with 1965 yields.

Of the water applied in 1965, about 98 percent served the needs of farm, city, and industry. This is in addition to instream uses for fish, recreation, and water quality. Increases in irrigation supply will require complementary increases in drainage works. In 2020, municipal and industrial requirements for water will triple, and requirements for land will double, those of 1965. Such increases in requirements will create problems of water supply, waste water disposal, zoning and open space.

Commercial Navigation

Commercial ships moving through coastal and inland ports play an increasingly important role in the growth of the California Region. In 1967, exports and imports amounted to five billion dollars.

Commercial navigation needs are reported in tons of waterborne commerce.



Petroleum and petroleum products will represent an estimated sixty percent of such commerce by 2020. Foreign commerce, particularly imports, will grow considerably.

Figure 19 projects the needs for waterborne commerce. Although both BASE PLAN and OBERS projections correspond regionwide, the OBERS projections would result in about 7.6 million more tons of cargo moving through the Los Angeles-Long Beach harbors in the South Coastal Subregion by the year 2020. This increase would be offset by a corresponding decrease in waterborne commerce at ports in the San Francisco Bay Delta-Central Sierra Subregions.

As a result of radical changes in vessel design and cargo-handling techniques, many existing waterways and port facilities are obsolescent. To retain competitive status with other world ports and to meet the requirements of extreme-draft petroleum tankers, dry-bulk carriers, and container-ships, port facilities must undergo major modification.

To accommodate larger ships, existing channels and basins must be deepened, and, in some instances, lengthened; land areas must be expanded; the investment in terminal and transfer facilities must be substantially increased. Specialized bulk-loading and container-handling terminals require far greater acreages of backup land per ship than do the conventional break-bulk, general-cargo wharves.

The port complexes of the San Francisco Bay and South Coastal Subregions must bear the brunt of the growing needs. Together these facilities handled about eighty percent of the Region's waterborne commerce in 1965. They are expected to handle more than ninety percent in 2020.

Recreational Navigation

Increases in population, leisure time, and disposable income have resulted in increases in the number of shallow draft boats. The future needs of recreational navigation are assessed in terms of permanent berthing, transient moorings and launching lanes required to accommodate projected shallow draft boat populations.

Transient moorings would require all-weather protection and necessary support facilities within harbors of refuge or multiple-purpose harbors. The needed coastal harbors of refuge would provide new boating destinations, encourage cruising, and open presently under-used fishing grounds to recreational fishing (Figure 20).

Figure 20: RECREATIONAL NAVIGATION NEEDS

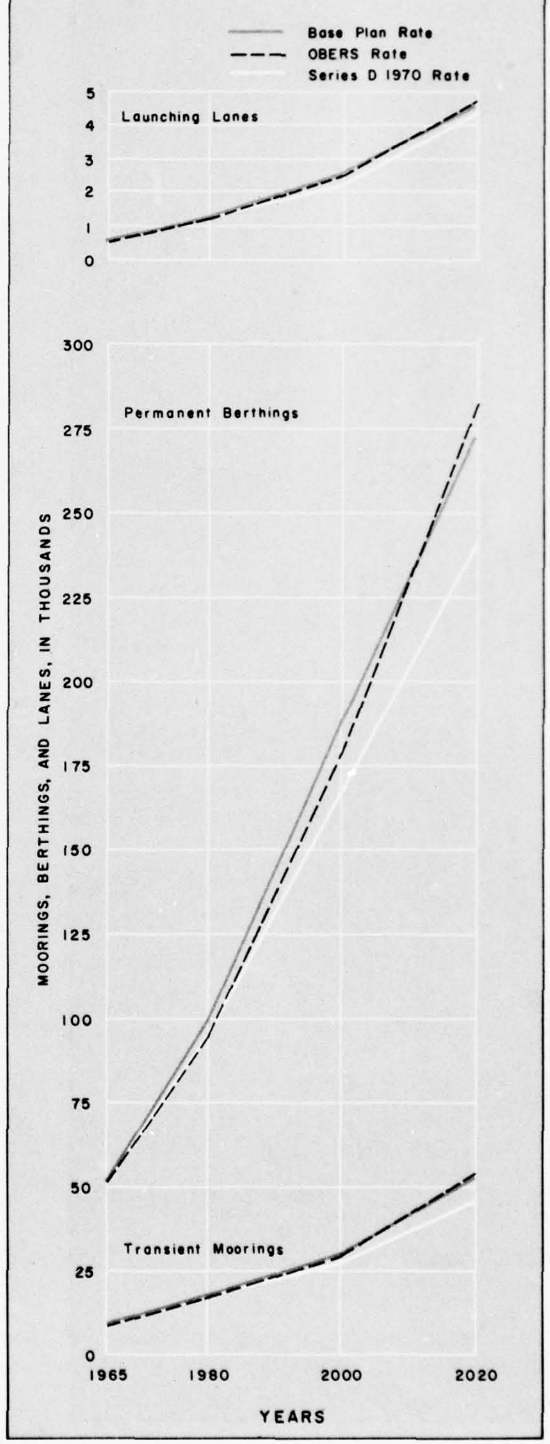
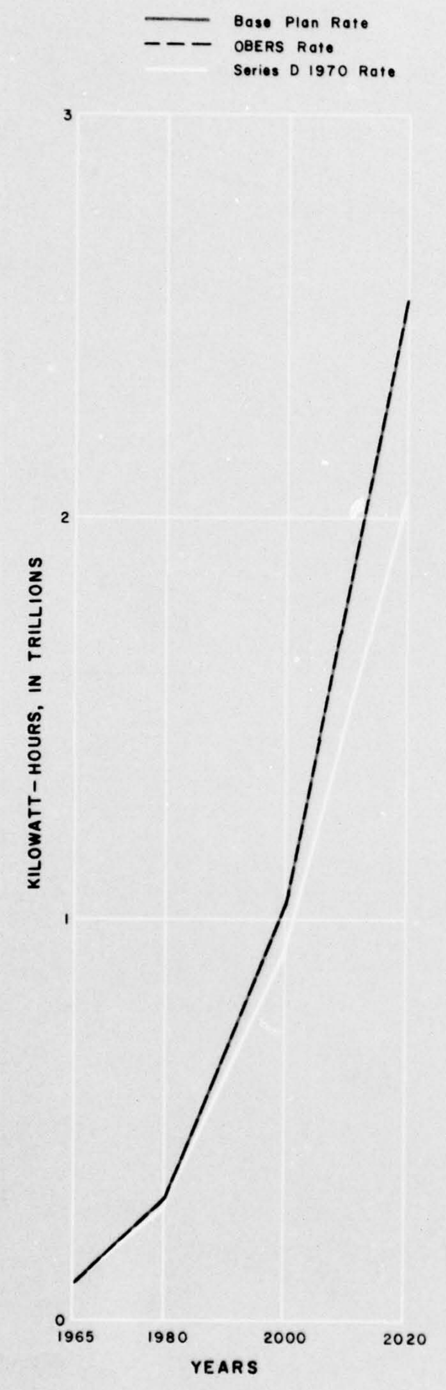


Figure 21: ELECTRIC POWER NEEDS



Electric Power

The Region's need for electric power in 2020 will be twenty to twenty-five times that in 1965 (Figure 21). Hydroelectric powerplants will provide only about three percent of the electricity consumed, although their capacity will have doubled. Steam electric plants, many using nuclear fuels, will produce the remaining electricity. Powerplants will require about 36,000 acres of land. Transmission lines with voltages of 500 kilovolts or more will require 229,000 acres; lower voltage networks will require additional acreage. Freshwater consumption will increase from about 25,000 acre-feet in 1965 to about 80,000 acre-feet in 2020. The large amounts of cooling water required for steam-electric plants would be available at seashore sites although construction at such sites will involve problems of land use and water temperature. Legal and institutional problems of site regulation and licensing will increase.

Figure 22: POSSIBLE WILD AND SCENIC RIVERS

River	Subregion*								
	CC	CD	NC	NL	SB	SC	SFB	SJB	TB
American									
North Fork					X				
South Fork					X				
Carson									
East Fork				X					
Colorado		X							
Deer Creek					X				
Eel									
Mainstem			X						
Middle Fork			X						
South Fork			X						
Feather									
Middle Fork South Branch					X				
North Fork					X				
Gualala			X						
Kern									
Mainstem									X
South Fork									X
Kings									X
Klamath			X						
Merced								X	
Mill Creek					X				
Navarro			X						
Redwood Creek			X						
Russian							X		
Sacramento					X				
Salmon			X						
San Joaquin								X	
San Lorenzo	X								
Scott			X						
Sespe Creek						X			
Shasta			X						
Sisquoc						X			
Smith			X						
Trinity									
Mainstem			X						
South Fork			X						
Tuolumne								X	
Van Duzen			X						
Yuba									
North Fork					X				
South Fork					X				
West Walker				X					

* CC: Central Coastal; CD: Colorado Desert; NC: North Coastal; NL: North Lahontan; SB: Sacramento Basin; SC: South Coastal; SFB: San Francisco Bay; SJB: San Joaquin Basin; TB: Tulare Basin

Part VI:

REGIONAL COMPREHENSIVE FRAMEWORK PLANS

Framework study guidelines established by the United States Water Resources Council state that a framework plan should show "the best use, or combination of uses, of water and related land resources of a region to meet foreseeable short- and long-term needs."

Such a plan recognizes the well being of the people as it considers both the preservation and the economic development of such natural resources as water, land, minerals, wildlife, recreation, forage, and timber. The National Environmental Policy Act of 1969 declares that all practicable means should be used to create conditions under which man and nature can harmoniously fulfill the social, economic, and other requirements of future generations of Americans. Framework plans provide one means to this end.

Planning Considerations

Framework plans broadly analyzed problems of water and related land resources and appraise probable solutions. The plans are preliminary. They weigh general relationships, reasoned approximations, available data and experienced judgment.

Water presently allocated but not yet put to use was reserved for the future use of the allottee. New water was provided to replace presently used water for which legally established adverse claims existed, as, for example, in the case of the Colorado River. Annual importations from the Colorado River were assumed not to exceed 4.4 million acre-feet, an amount less than historic imports but representing the March 9, 1964 Supreme Court Decision (Arizona vs California).

All plans carefully considered the preservation of natural areas such as deserts, wilderness, seashores, bays, deltas and rivers. Plans for the development of recreation, fisheries, wildlife and water particularly considered the preservation of wild rivers. Figure 22 names rivers which recreationists suggest might qualify as wild, scenic, or recreational.

The needs for development were based upon the three projected rates of economic growth: OBERS, Base Plan, and Series D-1970. Many types of need were considered: a need of agriculture for drainage and irrigation water; a need of cities and industry for water; needs for electric power, flood control, recreation, shoreline protection and development, and land treatment and management; the needs of navigation, fisheries, and wildlife; and a need for water of good quality.

A Plan for Water Development

By 2020, present water supply projects, including those under construction, will have eliminated the ground-water overdraft of 1965 and will have provided about 40 million acre-feet of water annually. Requirements for additional water annually to meet projected needs of the Region will range from five million acre-feet (Series D-1970 estimates) to 13 million acre-feet (Base Plan estimates).

Figure 23 catalogs a number of ways in which such water needs might be met. Some of these ways are time tested and conventional; others (under current test) approach the conventional; others are unproven but offer promise; and others are of theoretical promise, if practical obstacles could be overcome.

Not all of the ways can be applied in the Region: Because its ground water basins generally already are overdrawn, the Region cannot increase ground water pumping, although it might artificially recharge its basins or substitute ground water reservoirs for surface water reservoirs.

Existing data permitted complete analysis (including cost analysis) of a single plan for development. This plan draws heavily on North Coast streams as a source of water to satisfy requirements associated with rapid growth projections. The substitution of reclaimed waste water and desalinated sea water for some of the surface storage in this plan would permit greater enhancement

Table 2: A PLAN FOR DEVELOPMENT: Elements

Plan Element	Measurement Unit	Population Growth Rate											
		Base Plan				OBERS				Series D-1970			
		1966-1980	1981-2000	2001-2020	Total	1966-1980	1981-2000	2001-2020	Total	1966-1980	1981-2000	2001-2020	Total
Water Supply													
Dams													
Storage	Each	66	43	30	139	48	20	24	92	57	17	26	100
Diversion	Each	5	5	7	17	3	2	1	6	2	3	2	7
Reservoirs (Storage)	Acre-feet (1,000's)	28,840	27,580	23,410	79,830	26,556	16,237	13,959	56,752	27,221	4,140	10,525	41,886
Waste Water Reclamation	Acre-feet/Year (1,000's)	2	454	104	560	2	4	554	560	10	0	550	560
Canals	Miles	1,100	500	130	1,730	1,120	319	77	1,516	1,120	276	69	1,465
Pipelines	Miles	700	200	110	1,010	689	128	75	892	751	82	51	884
Distribution System	Acres (1,000's)	1,562	710	656	2,928	927	207	311	1,445	1,000	53	-56	997
Drainage System	Acres (1,000's)	1,490	450	350	2,290	1,404	202	242	1,848	1,435	414	297	2,146
Pumping Plants	Horsepower (1,000's)	4,500	900	1,900	7,300	4,144	767	628	5,539	4,245	756	1,174	6,175
Electric Power (Installed Capacity)													
Hydro	Megawatts (1,000's)	5	3	0	8	5	3	0	8	5	3	0	8
Thermal	Megawatts (1,000's)	29	140	301	470	29	140	301	470	27	122	241	390
Total	Megawatts (1,000's)	34	143	301	478	34	143	301	478	32	125	241	398
Navigation (Commercial)													
Channels													
Improvements	Miles	189	150	83	422	189	150	83	422	189	150	83	422
New	Miles	24	34	12	70	24	34	12	70	24	34	12	70
Breakwaters & Jetties	Miles	0.1	0.2	0.4	0.7	0.1	0.2	0.4	0.7	0.1	0.2	0.4	0.7
Basins & Anchorages													
Improvements	Acres	1,148	1,612	505	3,265	1,148	1,612	505	3,265	1,148	1,612	505	3,265
New	Acres	794	307	340	1,441	794	307	340	1,441	794	307	340	1,441
Cargo Handling	Acres	1,388	2,030	2,720	6,138	1,388	2,030	2,720	6,138	1,388	2,030	2,720	6,138
Berths	Each	32	54	59	145	32	54	59	145	32	54	59	145
Navigation (Recreational)													
Permanent Berthings	Each	50,275	86,000	84,800	221,075	49,600	80,925	93,185	223,710	47,575	72,500	72,900	192,975
Transient Moorings	Each	8,750	12,950	21,400	43,100	9,000	12,300	19,100	40,400	8,350	10,850	19,500	38,700
Launching Lanes	Each	548	1,231	1,960	3,739	564	1,287	1,998	3,849	533	1,211	1,925	3,669
Flood Control													
Reservoirs (Storage)	Acre-feet (1,000's)	4,564	5,458	1,995	12,017	4,564	4,691	2,075	11,330	4,564	4,691	2,075	11,330
Levee Banks	Miles	549	521	835	1,905	549	520	820	1,889	526	482	827	1,835
Channel Improvements	Miles	1,238	786	486	2,510	1,239	774	505	2,518	1,225	742	489	2,456
Floodplain Regulation	Miles of Stream	235	280	537	1,052	234	262	396	892	197	189	362	748
Watershed Management	Acres (1,000's)	3,617	4,507	344	8,468	3,617	4,507	344	8,468	3,617	4,507	344	8,468
Shoreline Protection & Development													
Stabilization	Miles	21.5	23.5	9.0	54.5	21.5	23.5	9.0	54.5	21.5	23.5	9.0	54.5
Beach													
Replenishment	Miles	4.5	7.5	6.0	18.0	4.5	7.5	6.0	18.0	4.5	7.5	6.0	18.0
New	Miles	2.0	8.0	20.0	30.0	2.0	8.0	20.0	30.0	2.0	8.0	20.0	30.0
Seawall	Miles	8.0	7.6	7.0	22.6	8.0	7.6	7.0	22.6	8.0	7.6	7.0	22.6
Recreation													
Scenic Shoreline	Miles	246	79	5	330	246	79	5	330	246	79	5	330
Beach													
Swimming	Miles	8	21	23	52	8	21	23	52	8	21	23	52
Non-swimming	Miles	16	3	3	22	16	3	3	22	16	3	3	22
Recreation													
Facilities (Class I & II)*	Acres (1,000's)	251	92	119	462	238	91	122	451	250	92	119	461
Water Surface	Acres (1,000's)	18	13	19	50	18	13	10	41	18	13	10	41
Recreation -	Days (1,000,000's)	275	238	331	844	275	238	329	842	275	238	329	842
Angler -	Days (1,000,000's)	2.9	5.2	6.4	14.5	2.9	5.2	6.4	14.5	-	-	-	-
Hunter -	Days (1,000,000's)	3.2	4.1	3.7	11.0	3.2	4.1	3.7	11.0	-	-	-	-
Water Quality (Municipal & Industrial)													
Waste Water Treatment	Population Equivalents** (1,000,000's)	33	60	82	175	33	60	82	175	31	54	66	151
Watershed Management													
Cropland													
Irrigated													
Water Application & Drainage	Acres (1,000's)	3,121	2,764	1,499	7,384	2,566	1,881	1,223	5,670	2,887	2,418	1,243	6,548
Other Cultivation	Acres (1,000's)	2,692	2,184	1,499	6,375	2,175	1,621	1,223	5,019	2,491	1,911	1,243	5,645
Management	Acres (1,000's)	3,026	2,633	1,499	7,158	2,513	2,066	1,223	5,802	2,800	2,304	1,243	6,347
Non-Irrigated	Acres (1,000's)	13	13	11	37	14	12	10	36	13	13	11	37
Grazing Land	Acres (1,000's)	4,050	5,219	124	9,393	4,050	5,219	124	9,393	4,050	5,219	124	9,393
Timberland	Acres (1,000's)	1,005	1,651	73	2,729	1,005	1,651	73	2,729	1,005	1,651	73	2,729
Erosion & Sediment	Acres (1,000's)	2,980	3,869	344	7,193	2,980	3,855	323	7,158	2,980	3,869	344	7,193

* For description of Recreation Land Classes, see Appendix XII

** Wasteloads from various sources on a common basis of 0.17 pounds of oxygen used per day in biochemical oxidation under a standard test.

Table 3: A PLAN FOR DEVELOPMENT: *Unmet Needs*

Plan Element	Measurement Unit	1965	Population Growth Rate								
			Base Plan			OBERS			Series D-1970		
			1980	2000	2020	1980	2000	2020	1980	2000	2020
Navigation (Recreational)											
Permanent Berthings	Each	10,320	6,290	8,450	10,500	4,790	7,890	17,240	5,310	5,830	6,700
Transient Moorings	Each	1,350	0	0	0	0	400	5,600	0	0	0
Launching Lanes	Each	0	0	19	55	0	0	116	0	0	0
Flood Control											
Damage Reduction	$1,000,000/year	107	104	101	118	100	93	95	101	94	97
Shoreline Protection & Development											
Damage Reduction (Erosion)	$1,000,000/year	9.9	7.3	5.6	4.4	7.3	5.6	4.4	7.3	5.6	4.4
Beach (Recreation)											
Swimming	Miles	0	0	0	5	0	9	44	0	0	5
Non-swimming	Miles	1	1	3	4	1	4	6	1	3	4
Recreaction											
Facilities (Class I & II)*	Acres (1,000's)	147	197	356	563	211	374	597	177	284	399
Water Surface	Acres (1,000's)	13	11	59	137	9	56	130	9	35	82
Recreation -	Days (1,000,000's)	432	518	918	1,474	519	923	1,483	463	710	961
Hunter (Waterfowl) -	Days (1,000,000's)	0	0.5	1.1	1.6	0.5	1.1	1.6	0.4	0.9	1.1
Water Quality (Municipal & Industrial)											
Waste Water Treatment	Population Equivalents** (1,000,000's)	14	10	0	0	10	0	0	10	0	0
Watershed Management											
Damage Reduction (Wildfire)	$1,000,000/year	16	16	16	16	16	16	16	16	16	16
Erosion & Sediment	Acres (1,000's)	7,200	4,200	300	0	4,200	300	0	4,200	300	0
Timber Production	Cubic feet/year (billions)	0	0.3	1.0	2.0	0.3	1.0	2.0	0.2	0.7	1.3

* For description of Recreation Land Classes, see Appendix XII

** Waste loads from various sources on a common basis of 0.17 pounds of oxygen per day in biochemical oxidation under a standard test. In 1965 the need was for treatment of a population equivalent of 31,000,000

of fish and wildlife habitat, and wild, scenic, and recreational rivers. Table 2 describes elements of the plan for development; Table 3, *remaining* projected needs which this plan fails to meet.

The reservoirs and delivery systems of the plan will meet all projected water supply needs for municipal, industrial, and agricultural water. Its drainage system will meet all needs for agricultural drainage. Water supply elements of the plan also include the reclamation of 560,000 acre-feet of water annually by 2020.

Thermal powerplant elements of the plan will meet most of the projected electric power needs; hydroelectric plants will meet the rest.

Commercial navigation elements--channels, breakwaters, basins, berths, etc.--will meet all needs projected. Recreational navigation elements--berths, moorings, and launching lanes--will meet most needs projected.

Flood control elements, including those of floodplain regulation and watershed

Figure 23: WAYS TO MEET WATER NEEDS

Increase Natural Supply

Modify Weather
Convert Sea Water
Develop Geothermal Water
Import Water

Prevent Natural Waste

Develop Surface Storage
Use Ground Water Basin
Manage Watersheds
Suppress Evaporation

Reuse Water

Reclaim Waste Water

Reduce Water Demands

Improve Water Project Operation
Improve Irrigation Efficiency
Reduce Municipal Water Use
Reduce Industrial Water Use
Increase Crop Yields

Reduce Food and Fiber Demands

Import Goods and Services

management, generally will hold flood damages (which otherwise would have increased at least five times) to 1965 levels. Attempts toward further reductions would not be practicable because of the non-concentrated remaining flood damages.

Shoreline protection elements include shoreline stabilization and beach replenishment, seawall construction and new beaches. Shoreline development elements include zoning and the acquisition of additional scenic shoreline and beaches. Plan elements will not meet all projected shoreline protection needs: attempts to eliminate all shoreline erosion completely, for example, would be impractical. Nor will they meet all needs for beaches: the amount of suitable shoreline is limited.

Recreational elements (excluding navigation) will provide for an additional 844 million recreation days of use in 2020. BASE PLAN projections show that urban needs for an additional 1,474,000,000 recreation days will remain unmet. Indeed, recreational elements of the plan for development outlined here will meet only 37 percent of total needs, and non-federal agencies will meet only one-fifth of the needs they would be expected to satisfy. Although existing physical, legal, institutional, and financial constraints render additional development unlikely, Appendix XII does discuss development plans which assume no such constraints.

Fish and wildlife elements of the plan for development will meet all needs except those for waterfowl hunter-days. The Region will lack sufficient waterfowl habitat and, thus, sufficient waterfowl.

Water quality elements will provide for secondary treatment at all new facilities and will upgrade existing facilities, and upon replacement, to provide secondary treatment. By 1980, some facilities will provide secondary treatment; by 2000, all facilities will do

Table 4: A PLAN FOR DEVELOPMENT:

Plan Element	Population Growth Rate							
	Base Plan							
	Installation				Annual Operation, Maintenance, Replacement			
	1966-1980	1981-2000	2001-2020	Total	Incremental 1980	Incremental 2000	Incremental 2020	1966-1980
	WATER DEVELOPMENT COSTS							
Water Supply								
Irrigation, Drainage	2,227	2,414	1,018	5,659	33.2	33.1	9.5	1,462
Municipal, Industrial, Treatment	2,767	1,716	2,951	7,434	96.4	54.2	76.0	2,615
Electric Power (Hydro)	1,101	647	0	1,748	13.0	9.0	0	1,101
Navigation	500	906	936	2,342	13.1	21.0	25.3	502
Flood Control	1,412	1,474	1,006	3,892	11.0	16.2	14.1	1,410
Shoreline Protection & Development	70	63	54	187	0.8	1.1	0.8	70
Recreation	142	75	100	317	4.2	1.5	3.0	85
Fish & Wildlife	32	49	0	81	2.7	4.9	0	32
Water Quality	2,350	3,221	3,065	8,636	43.3	59.4	65.8	2,316
Watershed Management*	65	64	31	160	7.2	17.8	25.3	65
Subtotal	10,666	10,629	9,161	30,456	224.9	218.2	219.8	9,658
Federal	(5,273)	(7,075)	(5,834)	(18,182)	(70.4)	(82.9)	(79.2)	(4,389)
Non-Federal	(5,393)	(3,554)	(3,327)	(12,274)	(154.5)	(135.3)	(140.6)	(5,269)
	ASSOCIATED COSTS							
Electric Power								
Thermal	3,373	14,189	31,523	49,085	410.0	1,969.0	4,164.0	3,373
Transmission Lines	2,766	10,360	20,800	33,926	73.1	273.1	423.0	2,766
Recreation	866	810	1,111	2,787	91.7	77.5	106.0	870
Watershed Management	978	1,086	855	2,919	181.0	353.8	580.2	824
Subtotal	7,983	26,445	54,289	88,717	755.8	2,673.4	5,273.2	7,833
	TOTAL COSTS							
TOTAL	18,649	37,074	63,450	119,173	980.7	2,891.6	5,493.0	17,491

*** Includes costs of supplying water for mining**

**** Not available**

so. By this latter year, water quality elements will meet all needs for treatment of municipal and industrial waste water. In addition to such treatment, water quality elements will treat agricultural drainage, will collect harbor wastes, will eliminate toxic drainage from mines, will manage water quality in the Salton Sea and in reservoir systems, will study specific problem areas, and will develop a mathematical model of water quality (and quantity) for a major part of the Region.

Watershed management elements of the plan for development will attempt to manage, treat and develop lands, and to improve yields. They will provide for the partial suppression of wildfire, erosion, and sedimentation; to provide complete suppression would prove uneconomic. They will help meet the need for food and fiber with programs for cropland, grazing land and timberland. Under the best management, however, the Region could produce only an estimated 1,400,000,000 cubic feet of timber annually, an amount which falls far short of its needs in 2020. Thus it will have to increase imports of timber. Similarly, it will have to increase imports of feed grain, livestock and

Costs, in Million Dollars

Population Growth Rate												
OBERS						Series D-1970						
Installation			Annual Operation, Maintenance, Replacement			Installation				Annual Operation, Maintenance, Replacement		
1981-	2001-	Total	Incremental			1966-	1981	2001-	Total	Incremental		
2000	2020		1980	2000	2020	1980	2000	2020		1980	2000	2020
WATER DEVELOPMENT COSTS												
1,690	536	3,688	16.1	23.7	9.1	1,675	1,467	488	3,630	29.5	25.6	3.6
1,497	1,857	5,969	75.4	45.6	60.7	2,645	754	892	4,291	71.8	34.0	36.4
647	0	1,748	13.0	9.0	0	1,101	647	0	1,748	13.0	9.0	0
930	1,051	2,483	13.1	21.5	26.1	499	846	882	2,227	14.5	23.1	27.8
1,415	967	3,792	11.0	16.0	14.0	1,383	1,338	932	3,653	11.0	16.0	14.0
63	54	187	0.8	1.1	0.8	70	63	54	187	0.8	1.1	0.8
40	68	193	4.2	1.5	3.0	133	80	81	294	4.2	1.5	3.0
49	0	81	2.7	4.9	0	**	**	**	**	**	**	**
3,088	2,793	8,197	42.4	53.8	54.1	2,280	2,916	2,582	7,778	34.3	46.8	43.5
64	31	160	1.9	5.5	10.6	65	64	31	160	7.0	17.7	25.3
9,483	7,357	26,498	180.6	182.6	178.4	9,851	8,175	5,942	23,968	186.1	174.8	154.4
(6,077)	(4,060)	(14,526)	(43.4)	(64.5)	(50.9)	(4,593)	(5,029)	(3,182)	(12,804)	(51.9)	(66.7)	(53.5)
(3,406)	(3,297)	(11,972)	(137.2)	(118.1)	(127.5)	(5,258)	(3,146)	(2,760)	(11,164)	(134.2)	(108.1)	(100.9)
ASSOCIATED COSTS												
14,189	31,523	49,085	410.0	1,969.0	4,164.0	3,200	12,400	25,200	40,800	**	**	**
10,360	20,800	33,926	73.1	273.1	423.0	**	**	**	**	**	**	**
774	1,012	2,656.	92.0	74.8	98.7	854	689	862	2,405	90.8	68.4	87.4
948	781	2,553	169.3	321.8	540.3	921	989	710	2,620	173.4	328.1	525.3
26,271	54,116	88,220	744.4	2,638.7	5,226.0	**	**	**	**	**	**	**
TOTAL COSTS												
35,754	61,473	114,718	925.0	2,821.3	5,404.4	**	**	**	**	**	**	**

meat, because sufficient grazing land is not available and it will have to shift from rangeland grazing to greater use of concentrates.

Costs. Table 4 shows both water development costs (federal and non-federal) and associated costs of a plan for development. The associated costs are several times greater than the water development costs. The costs shown represent reconnaissance estimates and rest upon regional experience and 1965 price levels. They exclude costs of fish and wildlife research, of game-law enforcement, and of municipal water systems, on-farm domestic water systems, piers, wharves, warehouses, marinas, harbor access roads, and other facilities normally provided by local enterprise.

Of the water development costs, total costs of installation for 1966 through 2020 range from about $24 billion to $30 billion.

Average annual installation, operation, maintenance, and replacement costs between 1966 and 1980 would be about $700 million for OBERS and Series D-1970 projections, and about $800 million for Base Plan Projections.

For the first five years of this period, federal and non-federal agencies actually spent about $1.1 billion annually for water development, a good part of it representing the large investment by California in its State Water Project. Annual federal expenditures amounted to about $163 million of this amount, considerably less than the $300 million to $400 million estimated for OBERS and Base Plan projections respectively.

Environmental Impacts

The retention or creation of open space will help minimize the environmental impacts of intensified human activity. Nevertheless, expanding cities, ports, industries and utilities, lengthening roads, and increasing use of land for crops, recreation and timber surely will alter the present environment. The extent to which such alterations will impair the quality of life will depend upon the manner in which they are effected and the extent to which any adverse effects can be mitigated.

For example:

- Although fertilizers and pesticides will increase crop yield, they create well-publicized problems of residue disposal.
- Although the treatment of water to improve its quality would enhance habitat, aesthetics, and opportunities for recreation, it also would necessitate controlled disposal of salts and other treatment residue.
- Although desalination plants provide an alternative to reservoirs, they will increase both the need for adequate waste disposal and the demand for power.
- Although powerplants located along the ocean will provide the power needed to supply expanding cities, they will discharge waters whose possible thermal effects upon ocean environment require further study.

- Although levees, stream channelizations, and navigation facilities will enhance urban environment, their design to minimize adverse effects upon estuaries, lagoons, or coastal marshes will increase costs.

- Although increased efficiencies in the use of agricultural, industrial, and municipal water will save water, they will eliminate return flows which presently sustain wetlands and riparian vegetation.

- Although decreasing the sediment load of streams by preventing wildfire and erosion would improve the fishery, it would lessen the flow of sediments needed to sustain beaches.

- Although reservoirs would provide a lake fishery, they would eliminate wildlife habitat and a stream fishery; and although they would provide smooth water for sailing, they would eliminate white water for canoeing.

- Although controlled releases from reservoirs would reduce flow in times of flood and increase flow in times of drought, such modification of river regimen would change channel conditions and alter the rhythm of seasonal changes in habitat.

Evaluation of Plans

The attempt to combine individual plans for irrigation, power, flood control, etc., into a single master plan emphasized the problem of balancing economic growth against resource preservation. The resolution of problems of competing needs requires further specific study and the setting of priorities by the people of the Region. The need to build dams must be weighed against the need to preserve wild rivers. The need to preserve beaches must be weighed against the need to expand ports and construct powerplants at ocean sites.

All plans face the uncertainties of timing and of public acceptance.

Timing water development depends both upon the projection of needs employed (Base Plan, OBERS, Series D-1970) and upon the individual area involved. The differing projections call for water development to begin as early as 1980 or as late as 1995, but these estimates are for the Region as a whole. Individual areas might require specific development earlier or later than those specified by the projections.

Uncertainties of public acceptance face each level of government. The Federal Government, for example, could neither expand recreation funding nor use more public land for recreation without public acceptance. The state governments could not match federal recreation funding, nor acquire beaches, nor make certain state lands available for recreation without public acceptance. Local government could not provide tax incentives to encourage businessmen to meet local recreational needs without encouragement from citizens, neighborhoods, and schools.

Development of the overall plan will proceed by increments which meet immediate needs. Prior to adoption, each increment and its alternates should undergo legislative and civic review of possible short and long term environmental and economic effects, of public acceptability, and of needed funding priorities. In the past, about twenty years has elapsed between the initiation of planning and that of operation of a water development project. This time lapse probably will increase as projects come to require more intense legislative and civic weighing of environmental effects and of alternate plans.

Legislation Required

Appendix III discusses existing laws and institutions in areas of water, land, fish, wildlife, and aesthetic

resources, and in areas of environmental control. It relates these to their historical perspectives and recommends modifications which will meet the challenges of future development. It urges an increase in federal and state participation in the development and regulation of water and of water-related resources. It recommends development of a comprehensive regional (and national) water resources code. Such a code would cover the development, regulation, and coordination of all resources in the Region.

Projects outlined in this framework study would be constructed only as the

need for them is demonstrated. Legislatures will consider that need together with funding possibilities only as specific projects are proposed for legislative authorization.

Conclusions

Through 2020, the growing Region will possess resources of land and water to supply most of its needs. It will possess sufficient water to satisfy all inhabitants except possibly those of the North Lahontan Subregion, although eventually it will lack sufficient waterfowl to satisfy its hunters, and it will import meat, timber, and minerals in increasing amounts. Crop yields per acre and per acre-foot will continue to increase.

To meet its demands for electric power the Region must build large steam-electric plants along its Pacific Ocean shores; it must adopt site selection and construction guidelines which will keep the impact upon the environment within acceptable levels.

Water quality control measures will continue to lag behind needs until about 2000. The Region must coordinate its planning for control of water quality and for operation of reservoirs, and must further refine its laws and its institutional standards.

A major flood problem area, the Region must take additional measures, both non-structural and structural, so as to expand its program of flood control. The urgent need to control floods may necessitate earlier construction of multipurpose reservoirs.

The Region must supplement its existing programs for fish and game. It should provide the water and land needed to produce sufficient fish and game to match its projections of demand. It should provide recreational facilities at a rate which will match that of expanding recreational needs. It should provide parks and playgrounds for crowded cities and should plan to preserve areas of wilderness, seashore, open space, and historical and archeological interest. It should protect its seashore and recreational areas by zoning and by improving means of public access. It should carefully balance its needs for wild, scenic, or recreational streams against its needs for developed water supplies.

The Region will need to expand its facilities for commercial navigation to satisfy the continuing trend toward larger ships and specialized handling of cargo. It will need to expand facilities for shallow draft boats, and to provide harbors for their refuge from storms along its coastline. It will need to expand its control of shoreline erosion to protect increasing values.

Existing facilities for water supply will meet the Region's short-term needs for water. In the past, the Region has taken about 20 years to plan and then build each of its large water projects. In the future, this time span between the plan and its execution probably will lengthen: Sites are less desirable; consideration of alternate sites and of ecological factors will be more detailed.

At 1965 price levels, estimated probable average annual costs for planned water development between 1966 and 1980 ran between $700 to $800 million. Estimated actual average annual costs between 1966 and 1970 are $1.1 billion. Of this amount, estimated annual costs of the Federal Government are $163 million.

These framework studies have identified certain alterations to the environment which could result from increasingly intense use of the Region's resources. More specific studies undoubtedly will identify additional alterations. If the Region wishes both to satisfy its needs and to protect its environment, it must provide money, technical skills, and administrative skills. It must

develop public awareness of potential problems and possible solutions.

Further Studies

Further studies needed to develop plans, assess alternatives, and consider environmental effects include the following:

1. Studies to discover alternative means of providing water supply: (a) by determining the feasibility and environmental effects of large-scale plants combining power generation with the desalination of sea and waste water, and by then constructing and operating prototype plants, and (b) by determining the feasibility of geothermal steam wells as sources of water and power, and (c) by discovering ways to lower water consumption as a means to water conservation.

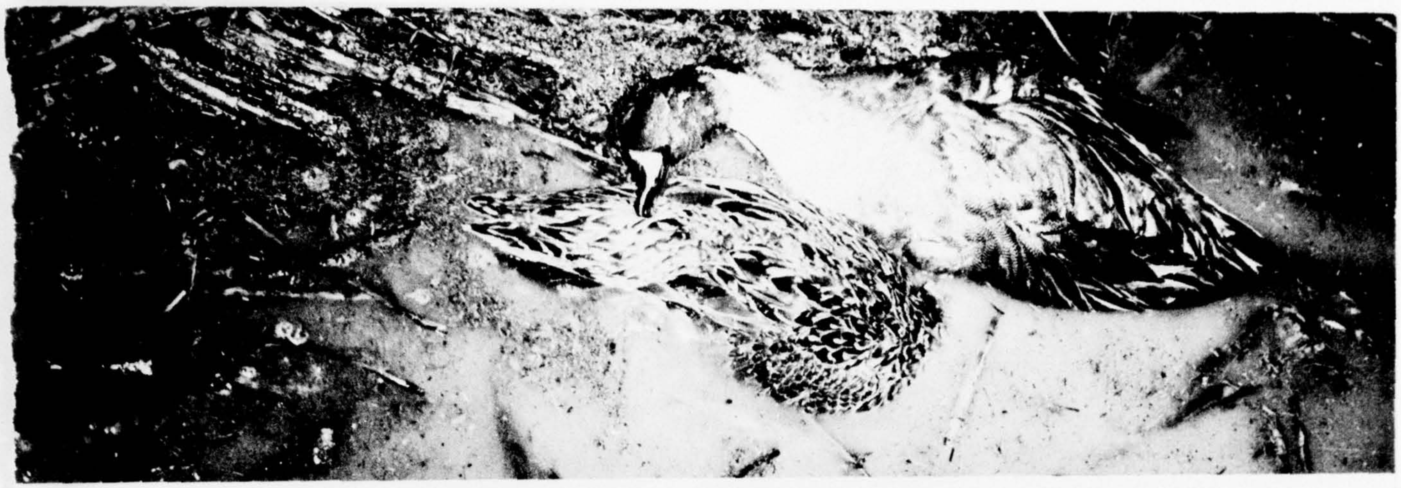
2. A study to determine the impact of changes in land use or vegetative cover upon erosion and sedimentation, and upon the quality and quantity of water in streams.

3. A study to suggest needed modifications in existing statutes affecting land management, and to suggest any necessary new statutes, and to suggest ways to encourage private landowners to retard runoff, erosion, and sedimentation.

4. A study of low-cost fire retardants, of new ways to determine the worth of resources protected from fire, and of new ways to detect forest and brush fires, and to predict their behavior.

5. A major study to determine the impact upon water quality of massive water development projects, and to include the collection of field data, the development of sophisticated mathematical models, and suggestions for the allocation of water during drought.

6. A study, requiring basic research findings, to discover how to control the production of algae in Upper Klamath Lake.



7. A study (a) to find ways to eliminate pollution from Spring Creek mining operations in the Sacramento Basin Subregion, and from animal feedlots and abandoned gas wells in the San Joaquin Basin Subregion; and (b) to determine the effects of polluted effluents from waste water disposal plants, thermal powerplants, animal feedlots, irrigated farmland, and other urban, industrial, and agricultural sources upon the coastal marine environment of the South Coastal Subregion; and (c) to find ways to alleviate those effects.

8. A study of toxicity, biostimulation, dispersion, and ocean outfalls in the San Francisco Bay area.

9. A study of the long-term effects upon the marine environment of continued offshore drilling, and of massive oil spills.

10. Studies to determine the value of building petroleum terminals in the open ocean off the California Coast as an alternative to centralizing petroleum terminals on deepened navigation channels in the harbors of San Francisco Bay, Los Angeles, and Long Beach.

11. Studies of the heavily populated South Coastal, San Francisco Bay, and Central Coastal Subregions to resolve recreation problems stemming from urban growth, from coastal development, and from needs to preserve open space.

12. Studies of the North Coastal Subregion to resolve potential conflicts between projects involving construction and those involving preservation of wild and scenic rivers.

13. More intensive study to determine specific outdoor recreation developments to satisfy unmet demands in heavily populated areas.

14. A study to determine specific fishery and wildlife habitat developments to satisfy the unmet demands of anglers and hunters.

15. A study to analyze further the impact of storage and conveyance plans on the fishery and wildlife habitat of the North Coastal, Sacramento Basin, and Delta-Central Sierra Subregions.

16. A study to determine acceptable sites for thermal-electric powerplants.

17. Studies of the littoral drift of sand along the coastline and of the effects of docks, fills, jetties, and other development along the coastline.

Recommendations

1. Use these studies as a guide to the preservation and development of the water and related land resources of the Region.

2. Accelerate study of possible reconciliation among conflicting demands of development and preservation.

3. Act to preserve those shorelines, wilderness areas, wild and scenic

rivers, and other natural and historic areas which study shows should be set aside for continual enjoyment.

4. Carry out the studies listed under "Conclusions".

5. Accelerate current programs to reduce floods, erosion, wildfire, and degradation of water quality, as well as current programs to manage land so as to preserve its productive capacity as range land and timberland and farm land; develop specific plans for recreation, fish, and wildlife facilities; study problems of coastal shoreline, estuaries and electric power supply; assess environmental effects; and involve federal, state and local governments, as well as private interests, in all planning.

6. Initiate further specific studies of the development of water supplies by water storage and stream regulation, including, for consideration by the public and the legislature, assessments of environmental impact and of alternative approaches.

7. Strengthen and coordinate legal and institutional standards; and obtain further legislative guidance regarding the balance between preservation and orderly development.

8. Provide flexible plans which incorporate alternatives that will accommodate changing conditions; periodically review and update framework plans.

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